17 December 2018

ADDENDUM 1
Project-Specific Quality Assurance Project Plan
PFAS Preliminary Assessment/Site Inspection

Joint Base Lewis-McChord

JBLM, Washington

Joint Base Lewis-McChord Public Works – Environmental Division
IMLM-PWE
MS 17 Box 339500
Joint Base Lewis-McChord, Washington 98433

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QAPP Worksheet #1 -- Title and Approval Page

Project-Specific Quality Assurance Project Plan (QAPP),
Addendum 1
PFOS/PFOA Preliminary Assessment/Site Inspection
Joint Base Lewis-McChord, Washington

December 17, 2018

Prepared for
Joint Base Lewis-McChord Public Works-Environmental Division
IMLM-PWE
MS 17 Box 339500
Joint Base Lewis-McChord, Washington 98433

Prepared by
AECOM Technical Services, Inc.
1111 3rd Avenue, Suite 1400
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206-438-2700

Prepared under
U.S. Contract No. W912DQ-15-D-3011
Task Order W912DW17F2085
And
U.S. Contract No. W912DW18D1014
Task Order W912DW18F2107

Approval Signatures:

Meseret Ghebresllassie/JBLM IR Program Manager Date

William Graney/USACE Seattle District Project Manager Date

Gregory T. Burgess/AECOM Project Manager Date

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EXECUTIVE SUMMARY

On behalf of the Joint Base Lewis-McChord (JBLM) Public Works Environmental Division IMLM-PWE, under contract to the U.S. Army Corps of Engineers (USACE), Seattle District, AECOM Technical Services, Inc. (AECOM) is conducting a Site Inspection (SI) for per- and poly-fluoroalkyl substances (PFASs) at Joint Base Lewis-McChord (JBLM) located in Pierce County, Washington. The goal of the SI is to identify PFAS source areas that have the potential to impact drinking water production wells at the installation. In 2016, the U.S. Environmental Protection Agency (U.S. EPA) issued a Drinking Water Health Advisory Level (HAL) of 70 parts per trillion (ppt) for the combined concentration of two specific PFAS compounds, Perfluorosulfonic acid (PFOS) and Perfluorooctanoic acid (PFOA). PFAS compounds are present in Aqueous Film Forming Foam (AFFF), which is used for the training of and extinguishing petroleum fires. PFAS compounds are also used in the manufacturing of intermediary products and hundreds of articles of commerce used in electronics, aerospace/defense, building/construction, alternative energy, automotive, semiconductors, military, healthcare, outdoor apparel/equipment, and chemical/pharmaceutical manufacturing. Data collection for a Preliminary Assessment (PA) was performed to identify potential source areas at JBLM to support the sampling efforts described herein.

The findings of the PA are summarized in Worksheet #10. Based on the PA data collection, 52 potential source areas were identified. These potential sources can be generalized as:

- Fire training areas
- Fire-fighting equipment testing areas
- Hangars with AFFF Systems
- AFFF storage areas
- Emergency response equipment
- Landfills
- Processes that used products potentially containing PFAS compounds

Source areas were prioritized for sampling based on the following:

- Historical/anecdotal information for largest AFFF release volumes
- Proximity to impacted drinking water production wells
- Areas with direct pathways to impacted drinking water production wells

The data collected during the PA was used to guide the Site Inspection (SI) Phase I sampling event, which consisted of sampling existing monitoring wells and one surface water location within or adjacent to suspected source areas. The Phase I event was performed between June 6 to 26, 2018, and included sample collection in the following suspected source areas identified during the PA:

- McChord Hangars, Runways, and Clover Creek
- Fire Training Area FT029, FT032, and Landfill 13 (McChord Field)
- Landfills 005 and 006 (American Lake Garden Tract)
- Landfill #2 (JBLM Logistics Center)
- Gray Field Hangars, Landfill #1, and SWMU47
- Historic waterproofing and laundry operations (south Fort Lewis)
- Landfill #4 (west Fort Lewis)

Groundwater/surface water samples collected during the Phase I event were analyzed for the 14 PFAS compounds identified in Worksheet #11. The analytical concentrations of the 6 UCMR-3 PFAS compounds were summed for each sample result and compared to the 70 ppt "screening level" to evaluate potential source areas. A summary of the results for each suspected source area evaluated during Phase I are provided below. Phase I sample locations are shown on Figures 17-1 through 17-14.

McChord Hangers, Runways, and Clover Creek

Thirteen groundwater samples and one surface water sample were collected within the immediate vicinity or downgradient of the McChord Hangars, runways, and Clover Creek. Groundwater samples were collected from monitoring wells: CW-62, CW-64, IW-2, CR-01, CW-14a, CW-14c, CW-14d, CW-15c, CW-15d, CW-29b, CW-4, MF-1, 1168-MW01, and LT-4. One surface water sample (Surface Water 1), was collected from within Clover Creek. Concentrations of the sum of six UCMR-3 compounds in groundwater collected from this set of monitoring wells ranged from 2.86 ppt (CW-15d) to 973 ppt (CW-15c). Surface Water 1 reported a concentration (six UCMR 3 compounds) of 35.69 ppt. Nine of the 13 samples have a sum of the 6 UCMR-3 compounds at concentrations greater than the HAL of 70 ppt. These summed concentrations range from 112.7 to 973.3 ppt.

Fire Training Area FT029, FT032, and Landfill 13

Seven groundwater samples were collected from existing monitoring wells to assess source potential associated with fire training areas FT029, FT032, and Landfill 13. Groundwater samples were collected from monitoring wells: CW-12, FTA-4a, FTA-4b, IH-1a, IH-1b, IH-3b, IH-3c, and CW-33c. The sum of six UCMR-3 compounds for samples collected from monitoring wells within FTA032 were 22,089 ppt (FTA-4a) to 37,170 ppt (FTA-4b). The sum of six UCMR-3 compounds for samples collected from monitoring wells associated with Landfill 13 ranged from non-detect (IH-1a) to 2,653 ppt (IH-3b). The groundwater sample from monitoring well CW-12 associated with fire training area FT029 had a reported concentration of 39.2 ppt. Existing monitoring well CW-33c located down/cross-gradient of fire training area FT032 and Landfill 13 was sampled and had a reported concentration of 24 ppt.

Landfills 005 and 006

Six groundwater samples were collected from existing monitoring wells associated with Landfills 0005 and 006. Samples were collected from monitoring wells: DA-21e, DA-7e, DO-2, DO-5b, DA-4a, and DA-4b. The sum of six UCMR-3 compounds in groundwater collected from these monitoring wells ranged from 0 ppt (DA-7e) to 81 ppt (DO-5b).

Landfill #2

Eight groundwater samples were collected from existing monitoring wells and treatment systems associated with Landfill #2. Monitoring wells LC-153, LC-230 and treatment systems samples LF-2 P&T Influent, LF-2 P&T Effluent, I-5 P&T Influent, I-5 P&T Effluent, SLA P&T Influent, and SLA P&T Effluent were sampled. The sum of six UCMR-3 compounds in groundwater collected from these monitoring wells and treatment systems ranged from 2.35 ppt (LF-2 P&T Effluent) to 65.36 ppt (I-5 P&T Effluent).

Gray Field Hangars, Landfill #1, and SWMU47

Two groundwater samples were collected from existing monitoring wells associated Landfill #1 (wells 84-CD-LF1-1 and 84-CD-LF1-4) and one sample was collected from an existing well associated with SWMU47 (98-IA-MW08). The sum of six UCMR-3 compounds in groundwater collected from these wells ranged from 3.41 ppt (84-CD-LF1-4) to 21.51 ppt (98-IA-MW-08).

Historic waterproofing and laundry operations

Two groundwater samples were collected from existing monitoring wells 4131-MW04 and 01035-MW01, located adjacent to former waterproofing and laundry operations. The sum of six UCMR-3 compounds in groundwater collected from 4131-MW04 and 01035-MW01 were 61.30 ppt and 169.3 ppt, respectively.

Landfill #4

Three groundwater samples were collected from existing monitoring wells located within Landfill #4: LF4-01, LF4-MW-10, and LF4-PNL1. The sum of six UCMR-3 compounds in groundwater collected from these wells ranged from 12.50 ppt (LF4-PNL1) to 19.28 ppt (LF4-01).

The results of the Phase I event led to the evaluation and selection of the Phase II sampling event locations described in Worksheet #17. This Addendum includes only Worksheets and Figures that require updating based on the selection of Phase II sampling locations. The updated Worksheets provided in this Addendum include: #2, #3, #4, #5, #6, #7, #9, #10, #11, #14, #16, #17, #18, and #20. The installation and sampling of new monitoring wells during Phase II is being performed under two contracting mechanisms. The monitoring wells described in Worksheet #17 that are 50 feet or less in depth will be installed and sampled by AECOM under contract W912DQ-15-D-3011. The monitoring wells described in Worksheet #17 that are greater than 50 feet in depth will be installed and sampled by a Brice Environmental and AECOM Joint Venture (Brice-AECOM JV) under contract W912DW18D1014.

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CONTENTS

ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
AEC	Army Environmental Command
AECOM	AECOM Technical Services, Inc.
AFFF	aqueous film forming foam
AOC	Area of Concern
amu	atomic mass unit
ARFF	airport rescue fire fighting
bgs	below ground surface
BRH	Bush, Roed and Hitchings
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CoC	chain of custody
CSM	conceptual site model
DL	detection limit
DO	dissolved oxygen
DoD	U.S. Department of Defense
DOH	[Washington] State Department of Health
DOT	Department of Transportation
Ecology	Washington State Department of Ecology
ELAP	Environmental Laboratory Approval Program
ELLE	Eurofins Lancaster Laboratory
EPA	[U.S.] Environmental Protection Agency
HAL	health advisory level
HPLC/MS/MS	high pressure liquid chromatography/tandem mass spectrometry
ICAL	initial calibration
ICV	initial calibration verification
IDW	investigation-derived waste
IR	Installation Restoration
IRP	Installation Restoration Program
ISC	instrument sensitivity check
JBLM	Joint Base Lewis-McChord
LCS	laboratory control sample
LM	Lewis Main
LOD	limit of detection
LOQ	limit of quantitation
MB	method blank
MDL	method detection limit
MF	McChord Field
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicate
MTCA	Model Toxics Control Act
NA	not applicable
NAVD	North American Vertical Datum

ABBREVIATIONS AND ACRONYMS (continued)

NE	not established
NEtFOSAA	n-ethyl perfluorooctanesulfonamidoacetic acid
NFA	No Further Action
NFRAP	No Further Remedial Action Planned
NMeFOSAA	n-methyl perfluorooctanesulfonamidoacetic acid
ORP	oxidation reduction potential
PA	preliminary assessment
PFAS	poly- and perfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFC	perfluorinated compound
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxS	perfluorohexanesulfonic acid
PFHxA	perfluorohexanoic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	perfluorosulfonic acid
PFTA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnA	perfluoroundecanoic acid
PID	photoionization detector
PM	Project Manager
PRQL	project-required quantitation limit
ppt	parts per trillion
PQL	project quantitation limit
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
RSL	regional screening level
SOP	standard operating procedure
SPE	solid-phase extraction
TPP	technical project planning
UCMR 3	Third Unregulated Contaminant Monitoring Rule
UFP-QAPP	Uniform Federal Policy for Quality Assurance Plan
USCS	Unified Soil Classification System
USACE	U.S. Army Corps of Engineers
WAC	Washington Administrative Code

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QAPP Worksheet #2 -- QAPP Identifying Information

Site Name/Number: Joint Base Lewis-McChord
Contractor Name: AECOM and Brice-AECOM JV
Contract Number: W912DQ-15-D-3011 and W912DW18D1014
Contract Title: PFOS/PFOA CERCLA Site Inspection
Joint Base Lewis McChord, Washington (W912DQ-15-D-3011)
and Additional Monitoring Well Installation
Joint Base Lewis McChord, Washington (W912DW18D1014)
Task Order: W912DW17F2085 and W912DW18F2107

1. This Quality Assurance Project Plan (QAPP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP) (EPA 2012) and *Guidance for Quality Assurance Project Plans* (EPA QA/G-5) (EPA 2002).
2. Regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
3. This is a project-specific QAPP.
4. Organizational partners (stakeholders) and connection with lead organization: Joint Base Lewis-McChord (JBLM), U.S. Army Corps of Engineers (USACE), Environmental Protection Agency (EPA), Region 10 (Stakeholder), Washington Department of Ecology (Ecology), and Washington Department of Health (DOH). This group collectively comprises the Technical Project Team.
5. Lead organization: JBLM Installation Restoration Program (IRP)
6. Contracting agency: U.S. Army Corps of Engineers (USACE) Seattle District
7. If any required QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion below:

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
A. Project Management		
Documentation		
1	Title and Approval Page	
2	QAPP Identifying Information	
3	Distribution List	
4	Project Personnel Sign-Off Sheet	
Project Organization		
5	Project Organizational Chart	
6	Communication Pathways	
7	Personnel Responsibilities and Qualifications Table	
8	Special Personnel Training Requirements Table	Information to be provided in Health and Safety Plan and Accident Prevention Plan
Project Planning/Problem Definition		
9	Project Scoping Session Participants Sheet	
10	Problem Definition, Site History, and Background.	

QAPP Worksheet #2 -- QAPP Identifying Information (Continued)

UFP-QAPP Worksheet #	Required Information	Crosswalk to Related Information
	Site Maps (historical and present)	
11	Site-Specific Project Quality Objectives/Systematic Planning Process Statements	Refers reader to Worksheets #12, #15, #17, and #18
12	Field Quality Control Samples	
13	Sources of Secondary Data and Information Secondary Data Criteria and Limitations Table	
14	Summary of Project Tasks	Refers reader to Worksheets #12, #16, and #17
15	Reference Limits and Evaluation Table	
16	Project Schedule/Timeline Table	
B. Measurement Data Acquisition		
Sampling Tasks		
17	Sampling Design and Rationale Sample Location Maps	Refers reader to Worksheet #12
18	Sampling Locations and Methods/SOP Requirements Table	
19	Analytical Methods/SOP Requirements Table	
20	Field Quality Control Sample Summary Table	
21	Project Sampling SOP References Table Sampling SOPs	
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	
Analytical Tasks		
23	Analytical SOP References Table	
24	Analytical Instrument Calibration Table	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	
Sample Collection		
26	Sample Handling System, Documentation Collection, Tracking, Archiving, and Disposal	
27	Sample Custody Requirements	
Quality Control Samples		
28	Laboratory QC Samples Table	Refers reader to Worksheet #12
Data Management Tasks		
29	Project Documents and Records Table	
30	Analytical Services Table	Refers reader to Worksheets #11 and #18
C. Assessment Oversight		
31	Planned Project Assessments Table	
32	Assessment Findings and Corrective Action Responses	
33	QA Management Reports Table	
D. Data Review		
34	Verification (Step I) Process Table	
35	Validation (Steps IIa and IIb) Process Table	Refers reader to Worksheet #12
36	Validation (Steps IIa and IIb) Summary Table	Refers reader to Worksheets #12, #18, and #24
37	Usability Assessment	Refers reader to Worksheets #11 and #12

QAPP Worksheet #3 -- Distribution List

Name of QAPP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Meseret Ghebresllassie	Installation Restoration (IR) PM	JBLM	253-477-3742	meseret.c.ghebresllassie.civ@ mail.mil
William Graney	Project Manager (PM)	USACE Seattle District	206-764-3494	William.P.Graney@usace.army.mil
Martin Roberts	Army Environmental Command support	Army Environmental Command	210-833-2591	Martin.e.roberts.civ@mail.mil
Chris Cora	PM	EPA	206-553-1478	cora.christopher@epa.gov
Chuck Hoffman	PM	Ecology	360-407-6344	chof461@ecy.wa.gov
Steve Hulsman	Chemical Water Quality Monitoring Program	Washington DOH	253-395-6777	steve.hulsman@doh.wa.gov
Matthew Lambiotte	Field Technical Representative	JBLM	253-966-1802	matthew.j.lambiotte.ctr@ mail.mil
Jamie Oakley	Program Manager	Brice-AECOM JV	907-275-2912	Jamie.oakley@briceenvironmental.com
Greg Burgess	PM	AECOM and Brice-AECOM JV	206-438-2047	greg.burgess@aecom.com
Rosa Gwinn	PFAS Technical Lead	AECOM and Brice AECOM-JV	301-585-1586	rosa.gwinn@aecom.com
Anthony Palmieri	Deputy PM/Field Team Lead	AECOM and Brice AECOM-JV	206-438-2417	anthony.palmieri@aecom.com
Kay Hower	PM	ELLE	717-556-7364	KayHower@eurofinsus.com
Dale Abernathy	Driller	Holt Services	253-604-4878	dabernathy@holtservicesinc. com
Taylor Schulte	Surveyor	Bush, Roed and Hitchings (BRH) Surveying	206-323-4144	taylors@brhinc.com

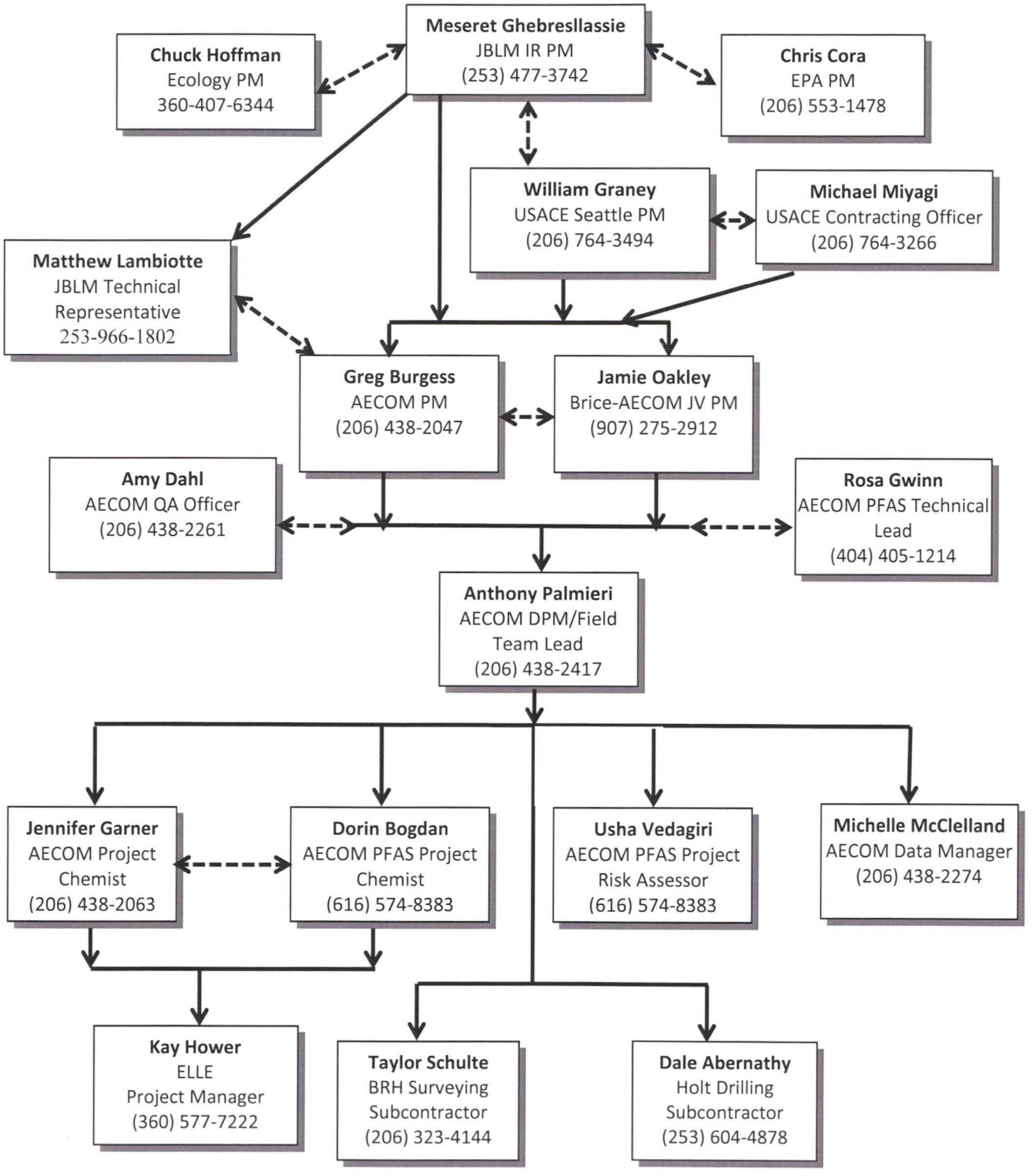
Note: Phase II well installation and sampling to be performed under Task Order W912DW17F2085, additional well installation and sampling to be performed under Task Order W912DW18F2107.

QAPP Worksheet #4 -- Project Personnel Sign-Off Sheet

Name of QAPP Recipients	Title/Role	Organization	Telephone Number (Optional)	Signature/ E-mail Receipt	QAPP Sections Reviewed	Date QAPP Read
Meseret Ghebresllassie	IR PM	JBLM	253-477-3742			
William Graney	PM	USACE Seattle District	206-764-3494			
Jamie Oakley	Program Manager	Brice-AECOM JV	907-275-2912			
Greg Burgess	PM	AECOM and Brice-AECOM JV	206-438-2047			
Rosa Gwinn	AECOM PFAS Technical Lead	AECOM and Brice-AECOM JV	301-585-1586			
Amy Dahl	Quality Assurance Officer (QAO)	AECOM and Brice-AECOM JV	206-438-2261			
Jennifer Garner	Project Chemist	AECOM and Brice-AECOM JV	206-438-2063			
Anthony Palmieri	Deputy PM/Field Team Lead	AECOM and Brice-AECOM JV	206-438-2417			

Note: Phase II well installation and sampling to be performed under Task Order W912DW17F2085, additional well installation and sampling to be performed under Task Order W912DW18F2107.

QAPP Worksheet #5 -- Project Organizational Chart



Note: Phase II well installation and sampling to be performed under Task Order W912DW17F2085, additional well installation and sampling to be performed under Task Order W912DW18F2107.

QAPP Worksheet #6 -- Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/ or e-mail	Procedure
Changes in scope or costs Authorization	USACE Seattle District Contracting Officer (KO)	Mike Miyagi	206.764.3266 Michael.m.miyagi@usace.army.mil	All changes in scope or costs require written approval from the USACE KO through coordination with USACE PM to the AECOM PM.
Technical approach to changes in scope or costs	USACE Seattle District PM	William Graney	206-764-3494 William.P.Graney@usace.army.mil	Discuss and approve all technical aspects of changes to scope or budget with AECOM PM prior to submitting to USACE KO for approval.
Regulatory agency interface	JBLM Installation Restoration Program Manager	Meseret Ghebresllassie	253-477-3742 meseret.c.ghebresllassie.civ@mail.mil	All changes to scope/procedures in the QAPP must be submitted to the JBLM PM via telephone, e-mail, or in writing. The JBLM will notify stakeholders as appropriate, direct AECOM, and submit changes to the USACE Seattle PM and KO as appropriate.
Program Communications	Brice-AECOM JV Program Manager	Jamie Oakley	907-275-2919 jamie.oakley@briceenvironmental.com	As needed, communicate program issues and solutions to the USACE PM for Task Order W912DW18F2107.
Field progress reports	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Periodic progress and schedule updates will be provided to JBLM PM and USACE PM via e-mail and telephone.
Stop work due to safety issues	AECOM Field Team Lead	Anthony Palmieri	206-438-2417 anthony.palmieri@aecom.com	Changes in site safety conditions that result in a stoppage of work will be communicated to the JBLM and USACE PM via telephone, e-mail, or in writing as soon as recognized.
Changes prior to field/laboratory work	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Changes in project conditions that result in changes to the QAPP, overall project scope, or costs will be communicated to the JBLM and USACE PM via telephone, e-mail, or in writing as soon as recognized.

QAPP Worksheet #6 -- Communication Pathway (Continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/ or e-mail	Procedure
Changes in the field	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Changes in project conditions that result in changes to the QAPP, overall project scope, or costs will be communicated to the JBLM PM, USACE PM, and the USACE Contracting Officer via telephone, e-mail, or in writing as soon as recognized.
Field corrective actions	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Corrective actions necessary to resolve field conditions not specified in the QAPP will be communicated to JBLM PM and USACE PM via telephone, e-mail, or in writing as soon as recognized.
Sample receipt variances	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Sample receipt conditions that result in a variance from those described in the QAPP will be communicated to the JBLM PM and USACE PM via telephone, e-mail, or in writing as soon as recognized.
Reporting laboratory quality variances	AECOM Project Chemist	Jennifer Garner	206-438-2063 jen.garner@aecom.com	Preliminary notification of issues affecting data quality will be communicated to the AECOM PM via telephone or e-mail as soon as recognized.
Analytical corrective actions	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Notification of corrective actions implemented to resolve issues affecting data quality will be communicated to the JBLM PM by the AECOM PM within 48 hours of identification via e-mail or telephone. Overall data usability will be documented in the submittal to JBLM.

QAPP Worksheet #6 -- Communication Pathway (Continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and/ or e-mail	Procedure
Reporting data validation issues	AECOM PFAS Project Chemist	Dorin Bogdan	616-574-8383 dorin.bogdan@aecom.com	Preliminary notification of issues affecting data quality will be communicated to the AECOM PM via telephone or e-mail as soon as recognized.
Data validation corrective actions	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Notification of corrective actions implemented to resolve issues affecting data quality will be communicated to the JBLM PM by the AECOM PM within 48 hours of identification via e-mail or telephone. Overall data usability will be documented in the submittal to JB LM and USACE.
Results of work	AECOM PM	Greg Burgess	206-438-2047 greg.burgess@aecom.com	Reports documenting project work will be submitted to the JBLM and USACE PM in accordance with the Statement of Work.

Note: Phase II well installation and sampling to be performed under Task Order W912DW17F2085, additional well installation and sampling to be performed under Task Order W912DW18F2107.

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
William Graney	PM	USACE Seattle	• Perform project Contract management on behalf of USACE. • Ensure that project scope of work is accomplished. • Oversee project budget and schedule. • Provide direction to the AECOM team according to USACE's contracting process
Meseret Ghebresllassie	Installation Restoration Program Manager	JBLM	• Lead Project Manager on behalf of JBLM. • Responsible for interaction with agencies and stakeholders. • Provide direction to the AECOM team according to Army Restoration Program Technical Guidance. • Act as lead interface with agencies and stakeholders.
Matthew Lambiotte	Field Technical Representative	JBLM	• Provide oversight of the contractor's activities and ensure compliance with this QAPP. • Escort and facilitate access to investigation areas at JBLM.
Jamie Oakley	Program Manager	Brice-AECOM JV	• Ensure program meets all required objectives and communicate with USACE PM as needed.
Greg Burgess	PM	AECOM	• Submit field sampling standard operating procedures (SOPs) to USACE for approval. • Coordinate work of AECOM and subcontractor personnel, ensuring that all adhere to project administration and technical requirements. • Monitor and report the progress of work, ensuring that project deliverables are completed on time and within budget. • Monitor budget and schedule, notifying the JBLM and USACE PMs of any changes that may require administrative action. • Ensure adherence to contract quality requirements, project scope of work, and quality control (QC) plans. • Ensure that all work meets the requirements of the technical specifications and complies with applicable codes and regulations. • Ensure that all work is conducted in a safe manner in accordance with the site safety and health plan. • Serve as the primary contact between JBLM, USACE, and AECOM staff for actions and information related to the work, and includes appropriate technical personnel in decision making. • Coordinate satisfactory resolution of nonconformances.
Rosa Gwinn	PFAS Technical Lead	AECOM	• Evaluate and interpret all PFAS data • Oversee program QC, including chemical data acquisition. • Work directly with contractor and USACE/JBLM staff to ensure implementation of the program QC plans relative to PFAS analyses. • Act as focal point for coordinating quality matters and

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table (Continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
			resolving quality issues relative to PFAS analyses. • Suspend project activities if quality standards are not being maintained.
			• Interface with USACE/JBLM on quality-related matters. • Perform reviews of audit reports prepared by others.
Amy Dahl	Project QAO	AECOM	• Provide and maintain effective QC system for all project tasks. • Monitor QC activities to ensure conformance with authorized policies and procedures and recommend improvements as necessary. • Conduct site meetings covering QC requirements where appropriate. • Perform reviews, inspections, and audits of AECOM and subcontractor activities to ensure QC procedures are being followed. • Identify and resolve nonconformances in accordance with the requirements of the QC procedures. • Stop work or require re-performance of any nonconformances resulting from improper application of prescribed procedures. • Maintain awareness of the entire project to detect conditions that may be adverse to quality. • Track corrective actions for conditions adverse to quality, verify documentation of corrective actions, and close out documentation upon completion. • Concur on nonconformance report dispositions and maintain system for tracking and analyzing reports. • Function as liaison with JBLM, USACE, and AECOM QC personnel.
Anthony Palmieri	Deputy PM/Field Team Lead	AECOM	• Manage and supervise field activities.
Anthony Palmieri	Deputy PM/Site Safety and Health Officer	AECOM	• Oversee all aspects of safety. • Document site conditions. • Ensure that all work is conducted in accordance with the QAPP. • Provide direction to field staff and subcontractors.
Jennifer Garner / Dorin Bogdan	Project Chemist / Project PFAS Chemist	AECOM	• Provide direction to laboratory and data validator. • Check electronic data for completeness.
Michelle McClelland	Project Data Manager	AECOM	• Oversee upload of data to data management system.
Usha Vedagiri	PFAS Project Risk Assessor	AECOM	• Assist project chemists when needed. • Assist with PFAS data interpretation.
Dale Abernathy	Project Manager	Holt Services	• Coordinate/oversee drilling and well installation services
Taylor Schulte	Project Manager	BRH Surveying	• Coordinate/oversee surveying of newly installed monitoring wells

QAPP Worksheet #7 -- Personnel Responsibilities and Qualifications Table (Continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
Kay Hower	PM	ELLE	• Review and implement analytical laboratory elements of this QAPP. • Manage laboratory analytical chemists to complete the sample analyses selected in this QAPP, according to the approved methods. • Monitor, review, and document the quality of all analytical chemistry work performed by laboratory under this QAPP. • Oversee management of analytical data. • Transmit completed data packages to the AECOM Project Chemist. • Promptly inform the AECOM Project Chemist of any laboratory analytical problems, data quality issues, or delays in sample analysis. • Promptly respond to any data quality issues identified through the independent data validation process.

Note: Phase II well installation and sampling to be performed under Task Order W912DW17F2085, additional well installation and sampling to be performed under Task Order W912DW18F2107.

QAPP Worksheet #9 -- Project Scoping Session Participants Sheet

Two Technical Project Planning (TPP) meetings were conducted with the Technical Project Team which consists of the following entities:

- JBLM
- U.S. Army Environmental Command (AEC)
- USACE Seattle District
- EPA, Region 10
- Ecology
- Washington DOH
-

The following are summaries of these meetings.

TPP #1 was held on December 6, 2017, to discuss the overall project approach, including the following:

1. Discuss PFOS/PFOA source assessment/identification scope
2. Develop consensus on PFOS/PFOA source area investigation prioritization criteria
3. Develop consensus on analyte list
4. Provide the Technical Project Team with a preliminary assessment of current site conditions based on existing data
5. Provide the Technical Project Team an overview of existing data
6. Develop consensus on Phase I monitoring well sampling locations
7. Develop consensus on path forward to identify potential PFOS/PFOA source areas
8. Develop consensus on potential source area prioritization criteria

TPP #2 was held on February 14, 2018, to address the following:

1. Discuss and review the overall project approach.
2. Review the status of the source assessment/identification effort and prioritize the potential source that had been identified to date.
3. Establish the QAPP question.
4. Select locations for Phase I sample collection and analysis.

QAPP Worksheet #9 -- Project Scoping Session Participants Sheet (Continued)

TPP #3 was held on September 18, 2018 to address the following:

1. Review and discuss the results of the Phase I sampling event.
2. Discuss and review the overall project approach.
3. Select locations for Phase II sample collection and analysis.

Attendees included representatives from the Technical Project Team and Lakewood Water District.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model

Background

JBLM is located about three miles south of Tacoma, Washington along Interstate 5, which bisects the installation (Figure 10-1, JBLM 2018). In 2005, Fort Lewis and McChord Air Force Base (AFB) were designated as a joint base (i.e., JBLM) under the Base Realignment and Closure program. The former McChord AFB (4,639 acres) was adjacent to the northeast boundary of the former Fort Lewis (86,198 acres). JBLM became fully functional in October 2010. The installation occupies 90,837 acres in Pierce and Thurston Counties, Washington. The mission of JBLM is to provide logistical support and maneuver areas, range and facilities for I Corps and supporting units. It also provides worldwide military airlift capability. JBLM supports an on-base population and in neighboring communities of more than 100,000 people including military personnel, families, civilian and contract employees, and retirees and their families. JBLM has an Army joint base commander and an Air Force deputy commander. Base services are managed and provided by the Army.

JBLM is surrounded by the communities of Lakewood to the north (population 58,000), Olympia, Lacey, and Tumwater (population 86,000) to the south, DuPont to the west (population 7,500), and unincorporated Spanaway/Parkland to the east.

Per- and polyfluoroalkyl substances (PFAS) are manufactured fluorinated organic chemicals that have been used in a wide variety of industrial and commercial products due to their valuable properties, which include fire resistance; dust suppression; and oil stain, grease, and water repellence. Examples of uses include carpets and furniture fabric, clothing, anti-stick surfaces for preparing and packaging food, dust suppression for metals plating, as well as polishes, waxes, and cleaning products. PFAS, including perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), are also components of aqueous film forming foam (AFFF), firefighting foam used by industry and the U.S. Department of Defense (DoD) since 1970 to fight petroleum fires.

PFAS are a class of hundreds of compounds that contain chains of various lengths of fluorine-carbon bonds. Fluorine-carbon bonds are one of the strongest bonds in nature; therefore, these compounds have distinct properties of strength, durability, heat-resistance, and stability. PFAS compounds are used in the manufacturing of intermediary products and hundreds of articles of commerce used in electronics, aerospace/defense, building/construction, alternative energy, automotive, semiconductors, military, healthcare, outdoor apparel/equipment, chemical/pharmaceutical manufacturing, and most notably in AFFF used for fire training and firefighting.

PFAS are persistent in the environment and have been found in surface water, soil, and groundwater. While consumer products and food packaging are the primary uses of PFAS containing materials, drinking water is identified as the primary exposure pathway at JBLM, at this time. Such contamination is typically localized and associated with a specific facility where

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

the chemicals were produced, used to manufacture other products, used for firefighting or firefighting training, or disposed of.

In May 2016, the U.S. EPA issued a Lifetime Health Advisory Level (HAL) level in drinking water of 70 parts per trillion (ppt; or 0.07 micrograms per liter [µg/L]) for PFOS and PFOA (individually or combined if both are detected in drinking water). EPA's HAL is protective of the most sensitive sub- populations while drinking the water over a lifetime. The EPA HAL is based on the effects of PFOS and PFOA on laboratory animals and epidemiological studies of human populations.

As part of the Army's commitment to supplying quality drinking water to its service members, family members, and civilians and in response to the HAL released by EPA, the Army implemented a comprehensive PFOS and PFOA testing program at the Army facilities that may have used AFFF or other PFOS/PFOA products.

On June 10, 2016, the Department of Army instructed all Army installations to conduct PFAS contamination assessments for known fire training areas, AFFF storage locations, hangars/buildings with AFFF suppression systems, fire equipment maintenance areas, and areas where emergency response operations required AFFF use as possible source areas. On August 29, 2016, an Army Guidance Memo for conducting PFAS assessments was finalized and included guidance on sample design and the specific sampling and analysis methods that should be used in PFAS-related site investigations (U.S. Army 2016). On February 20, 2018, an Army Guidance Memo was issued that requires PFAS assessments to include the 14 analytes that EPA Method 537 can identify (U.S. Army 2018).

At JBLM (Figures 10-2 and 10-3, JBLM 2018), AFFF was used for firefighter training at several locations on the east side of McChord Field's runway, near Lewis Main's Gray Army Airfield, and North Fort Lewis through the early 1990's. JBLM identified up to eleven historic fire training areas that could be the potential source for the drinking water production well impacts. The AFFF fire suppression systems are also potential source areas for PFOS/PFOA. The AFFF that is currently in hangar systems and in aircraft accident response fire-fighting vehicles is a formulation of AFFF with 8-carbon chain PFAS, (C8 AFFF). The stockpiles of AFFF and AFFF in fire-fighting vehicles have been replaced with AFFF that is not C8. The change out from C8 AFFF to non-C8 AFFF was performed because the non-C8 AFFF (C6 or less) is less toxic.

JBLM water systems are tested routinely in accordance with the Safe Drinking Water Act. When PFAS at Air Force installations around the country became an issue in April 2016, JBLM proactively began testing its drinking water sources for PFOS and PFOA. JBLM began testing water from the 23 drinking water production wells on the installation. Testing results between January and April 2017 confirmed the presence of PFAS compounds in five drinking water wells on JBLM exceeding the EPA HAL of 70 ppt including:

- North Well, McChord Field (MF) – 216 ppt
- South Well MF – 250 ppt

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

- Well #17, Lewis-Main (LM) 71 ppt
- Housing Well II (MF) – 72 ppt
- Golf Course Well #22 – 78 ppt

These well locations are shown on Figures 10-2 and 10-3 (JBLM 2018). All five wells were isolated, or already shut-off for other reasons, with water distribution for JBLM McChord Field and Lewis-Main/North adequately supplied by other wells that met the EPA HAL. On 31 May 17, point-of-use filtration devices were installed at the Golf Course Clubhouse and Well#22 was turned back on feeding only the clubhouse."

The geologic units within JBLM and the surrounding area consist primarily of Pleistocene-age glacial deposits. These units comprise a complex system of stacked aquifers and confining units, which include the following:

Upper Vashon Aquifer (A1): Vashon Drift (Steilacoom gravel, recessional outwash). Material consists of stratified sand, silt and gravel, thickness of 35 feet to >200 feet.

Confining Unit (A2): Vashon Drift (Vashon Till, ice contact, moraine and glaciolacustrine deposits). Material consists of clay, silt, sand and gravel, discontinuous/not present in places; can provide a conductive pathway between Upper Vashon Aquifer and Lower Vashon Aquifer; thickness ranges from a thin veneer to 150 feet on a regional scale.

Lower Vashon Aquifer (A3): Vashon Drift (advance outwash). Material consists of well-sorted sand or sand and gravel with silt and clay lenses; average thickness is 75 feet.

Confining Unit (B): Olympia Beds (Kitsap Formation), Lawton Clay. Material consists of primarily of silts and clays; thickness of 10-20 feet where present on JBLM; discontinuous/not present in places; can provide a conductive pathway between Vashon Aquifers and lower Sea Level Aquifer.

Sea Level Aquifer (C): Salmon Springs Drift, Penultimate Drift, Hayden Creek Drift, and Wingate Hill Drift (glacial drift). Materials consist of sand and gravel, pebble to cobble gravel, with minor lenses of silt, clay, till, and volcanic ash; thickness of 50 to 100 feet.

Confining Unit (D): Puyallup Formation. Material consists of alluvial and lacustrine sand, silt, clay, and occasional volcanic ash; average thickness is 100 feet.

Stuck Aquifer (E): Stuck Drift. Material consists primarily of silt, sand, and gravel with discontinuous till and lacustrine deposits; thickness ranges from a thin veneer to >200 feet below ground surface (bgs).

Confining Unit (F): Alderton Formation. Consists primarily of silt and clay, with minor lenses of sand and gravel; thickness ranges from 50 feet to > 300 feet.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

> ***Orting Aquifer (G):*** Orting Drift. Material consists primarily of stratified sand and gravel with discontinuous layers of till.

At this time, there is very little information to develop a specific conceptual site model (CSM) on an installation-wide or source-area-specific basis. A complete CSM requires identification of source areas, impacted media, transport mechanisms, and potential receptors. The purpose of this SI is to evaluate potential source area. A preliminary conceptual site model is as follows.

A preliminary assessment indicated that there are at least 52 potential PFAS source areas located in over 20 general areas at JBLM (Figure 10-4, JBLM 2018). All of these source areas are surface or near surface releases. There are twenty-three potential groundwater receptors (drinking water production wells) on the installation and multiple potential groundwater receptors off the installation. There are five aquifers identified at the site ranging from the surface to over 1,000 feet in depth, depending on location. Cross-sections in the vicinity of the JBLM Logistics Center, location shown on Figure 10-5 (JBLM 2018), which provide a generalized depiction of the localized geology, are provided as Figures 10-6 and 10-7 (JBLM 2018) (Borden and Troost, 2001). The flow path or process by which the PFAS surface releases have migrated through the aquifers and aquitards to reach these deep drinking water production wells is not understood. There are few monitoring wells that penetrate deep enough to provide an understanding of the transport path from these multiple source areas. Based on data available from previous CERLCA investigations and United States Geological Survey research (Savoca et al 2010), groundwater flow is generally to the northwest in the five aquifers. The Sea Level aquifer has a westerly flow path around American Lake. The primarily northwest flowing Clover Creek flows through McChord Field and could also be a transport mechanism off installation. Clover Creek flows near the fire training areas and just west of the McChord field hangars. Soil at the potential source areas could be acting as residual sources. PFAS compounds are not volatile and do not pose a vapor intrusion risk.

Problem Statement

PFOS/PFOA has been detected in water samples from five JBLM drinking water production wells at concentrations above the EPA HAL of 70 ppt. The source or sources of PFOS/PFOA in samples from these wells have not been identified. The complex geology, depth of drinking water production well screens, and inferred surface sources suggest that a fairly complex transport mechanism is required to get the PFOS/PFOA compounds from the source areas to the exposure points (drinking water production well screen intervals). The objective of this SI is to identify PFOS/PFOA source areas at JBLM.

Preliminary Assessment (PA) Data Collection – Potential PFAS Source Identification

A focused preliminary assessment was conducted at JBLM to support the site inspection that is planned herein. Results of the preliminary assessment are briefly summarized below. The primary objectives of the PA were:

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

1. Identify operations/activities, both current historic, of potential concern for potential contributions of PFOS/PFOA to drinking water drinking water production wells identified with PFAS concentrations at or exceeding HAL of 70 ppt
2. Identify potential pathways of PFAS to the environment
3. Prioritize potential source areas for Site Investigation

Source prioritization criteria were:

- Historical/anecdotal information for largest AFFF release volumes
- Proximity to impacted drinking water production wells
- Areas with most direct pathway to impacted drinking water production wells

The PA focused on AFFF storage and use (e.g. fire-fighting training areas, hangars fire suppression systems, crash/accident sites, accidental system releases or spills). Based on experience, other products/activities of interest included:

- Landfills
- Waterproofing operations
- Surfactant operations (e.g. vehicle wash, laundries)
- Dry wells (stormwater)

The PA screened for operations and areas of concern and focused on areas centered on obvious higher activity. The screening was based on:

- Fire-fighting training
- Areas with identified concerns based on map review (e.g. fire training areas and landfills)
- Spills
- Dry wells (stormwater)
- Known contaminated sites

The PA source identification tasks included:

- Interviews with Department of Public Works, environmental, and Public Safety personnel
- Reviewed historical information such as accident responses, aerial photographs, and other documentation
- Reviewed databases and sources:
    - P2 Enterprise, Environmental, Safety, Occupational Health- Management Information System
    - Spill Response Incident Reporting

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

- Aircraft accidents
- Information from environmental programs
- SWPPP – outfalls, dry wells
- Safety – AFFF system locations
- Visual site inspections
- Visits to potential areas of concern
- Interview personnel at or associated with areas of concern

Research Summary

Interviews identified that fire extinguishing systems utilizing AFFF were the operations used the highest volume of chemicals typically containing PFAS. Systems associated with AFFF storage and use at JBLM included aircraft hangars equipped with fire suppression systems and emergency response equipment. Each of the aircraft hangars equipped with fire suppression systems typically included one aboveground storage tank containing AFFF located in a mechanical room with associated pumps and piping. Piping distributes the AFFF to nozzles or deluge outlets mounted at strategic locations in the hangar interior, sometimes floor-mounted, sometimes ceiling mounted, and sometimes on structural members between the floor and ceiling.

Interviews also identified that the most significant discharge of AFFF directly to the environment likely was during firefighting training exercises and during routine adjustment of the foam spray patterns of Airport Rescue Fire Fighting (ARFF) vehicles. The fire-fighting training exercises occurred in areas located at McChord Field to the east of the runway, at Gray Field on the northeast portion of the airfield, and approximately 0.25-miles to the southeast of Gray Field. The routine adjustment of the foam spray patterns of ARFF vehicles occurred by spraying foam onto areas including flight-line areas on and around the perimeter of runways at McChord, and washing the resultant foam off the runways to adjacent permeable areas.

Other products/activities of interest include:

- Landfills - LF 13 received soil excavated from fire-training area FT032. A number of landfills received municipal wastes which could be PFAS sources. Lewis LF 5 includes storm water infiltration.
- Waterproofing – Historic canvas waterproofing operations were identified in the western portion of Fort Lewis and in the Fort Lewis Logistics Center and could be a PFAS source.
- Surfactant operations (e.g. vehicle wash racks, laundries)
    - Current and historic vehicle wash racks were identified at McChord airfield and at Fort Lewis south of Gray Field

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

  - Historic laundries were identified in the western portion of Fort Lewis and in the Fort Lewis Logistics Center

- Dry wells (stormwater) – the majority of the current dry wells are located in residential and office building areas. However, dry wells were located surrounding one fire station where AFFF has been utilized on ARFFs, and historically dry wells may have been located in or near more industrial areas.
  - Table 10-1 of JBLM 2018 presents a summary of the identified potential PFAS sources at JBLM.

Site MF-FT-27 McChord Field

Site MF-FT-27 is a former fire training area covering less than 1/4 acre, located along the north end of the main runway, east of the east taxiway and west of the perimeter road. Waste JP-4 and gasoline were used as fuels for fire training exercises at the site from 1960 to 1977. The fire training area did not contain a liner; however, the fuels reportedly floated on water before being ignited. Site MF-FT-27 is located on the upgradient side of the base. Twenty-four fire training exercises were conducted each year using about 300 gallons of fuel for each exercise (1982 CH2M Hill Installation Restoration Program Records Search). Ecology conducted an Initial Investigation at this site in November 1990. MF-FT-27 was included in the 27 February 1992 Consent Decree. A Site Hazard Assessment under the terms of the Consent Decree was conducted in 1993. Six sampling pits were excavated to a depth of 5 feet and soil samples were analyzed for petroleum products (1995 USAF Phase II Field Summary Report). Fuel contaminated soil was found in two of the pits, and about 6,000 cubic yards of contaminated soil was removed and treated at an on-base bioremediation/landfarming facility.

Following the removal, an examination of historic information, site inspections, and analytical results reveal that residual fuel remaining at this site will not adversely impact human health or the environment. An Air Force Decision Document was issued 25 August 1993, which recommended No Further Action (NFA) for this site (1993 USAF IRP NFA DD). Ecology concurred with the recommendation on 28 June 1995.

Site MF-FT-28 McChord Field

Site MF-FT-28 is a former fire training area covering less than 1/4 acre. It was located north of the hazardous cargo loading/unloading area and west of the perimeter road. The site was used for helicopter fire training for one to two years during the early 1960s. The Installation Restoration Program (IRP) Records Search stated that 40 to 50 fire training exercises were conducted during each year using flammable liquids such as JP-4 (1982 CH2M Hill Installation Restoration Program Records Search). Ecology conducted an Initial Investigation at this site in November 1990 and the site was listed in the 27 February 1992 Consent Decree.

Historic information, site inspections, and analytical results reveal that no potential contaminants reportedly released at this site will adversely impact human health or the environment. There are no contaminant pathways connecting the site to human or environmental receptors.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Air Force issued a NFA Decision Document on 25 in August 1993 (1993 USAF IRP NFA DD). Ecology issued NFA concurrence letters for MF-FT-28 on January 27, 1994 and June 28, 1995.

Site MF-FT-29 McChord Field

Site MF-FT-029 was reportedly a fire training area located approximately 1,200 feet northeast of the confluence of Clover Creek and Morey Creek between the perimeter road and the east base boundary. The general area is covered with regularly mowed native grasses. There is no Air Force knowledge or evidence of site use apart from its listing on old base maps. There is no evidence of environmental contamination emanating from this site (1982 CH2M Hill Installation Restoration Program Records Search).

Based on an examination of historical information, it is likely that this site was misidentified on old base maps. Inspections of the site did not indicate fire training activities. A NFA Decision Document was issued on 10 July 1990 (1990 USAF IRP NFA DD). Ecology concurred on 12 December 1990.

Site MF-FT-30 McChord Field

Site MF-FT-30 was an old fire training area covering less than 1/4 acre. The site was located southeast of the hazardous cargo loading/unloading area between Morey Pond and Clover Creek on the base. The site was used from approximately 1955 to 1960. The IRP Records Search stated that 35 fire training exercises were conducted each year using approximately 300 gallons of fuel for each exercise. Fuel and used solvents were floated on water before being ignited for the fire training exercises. The site did not have a soil liner (1982 CH2M Hill Installation Restoration Program Records Search).

Ecology conducted a Model Toxics Control Act (MTCA) Initial Investigation at this site on 16 November 1990 and requested confirmation sampling to determine if either a Site Hazard Assessment or No Further Remedial Action Planned (NFRAP) under MTCA was appropriate.

An examination of historic information, site inspections, and analytical results revealed that the contaminants reportedly released at this site are not adversely impacting human health or the environment. There are no contaminant pathways connecting the site to human or environmental receptors. No rationale can be identified for further investigation at this site. The Air Force concluded the site is finished and should be included within the base wide LTM program. A Decision Document was written in August 1993, which recommended NFRAP for this site (1993 USAF IRP NFA DD).

Site MF-FT-31 McChord Field

Site MF-FT-31 was an old fire training area that covered less than 1/4 acre. The site was located south of the hazardous cargo loading/unloading area on the south side of Morey Pond. Fire training exercises were conducted at the site from 1950 to 1955. The IRP Records Search stated that 30 exercises were conducted each year using approximately 300 gallons of fuel for each exercise. Fuel and other flammable liquids such as solvents were floated on water before being

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

ignited for the training exercise. The site did not contain a soil liner (1982 CH2M Hill Installation Restoration Program Records Search).

A MTCA Initial Investigation was conducted at this site in 1993 and carcinogenic polynuclear aromatic hydrocarbons (PAHs) were found above MTCA cleanup levels. PAHs are insoluble and have been established at other locations on base to present no threat to surface or ground water. There are no contaminant pathways connecting the site to human or environmental receptors. No rationale can be identified for further investigation at this site. The Air Force concluded the site is finished and should be included within the base wide LTM program. A Decision Document was written in August 1993 recommending NFRAP for FT-31 (1993 USAF IRP NFA DD). Ecology concurred that the site does not warrant further investigation because of the non-mobile nature of the contaminants. WDOE NFA concurrence letter for FT-31 signed June 28, 1995.

Site MF-FT-32 McChord Field

Site MF-FT-32 is located 500 feet south of Morey Creek and 500 feet inside the base eastern boundary. The fire training area was built in 1975 and use of the site discontinued in April 1990 due to air emissions restrictions. According to an IRP Decision Document (US Air Force Environmental Management Flight, 1993), the history of the site indicates FT-32 was used for simulated crash fire training beginning in 1976. Approximately ten exercises were carried out each year, by floating 300 to 400 gallons of pure or contaminated JP-4 fuel on water and then igniting the fuel to simulate an aircraft crash fire. The fire training area consisted of a 130-ft diameter diked, pit lined area with a 1-ft-thick impermeable clay lift. Jet fuel was delivered to the pit from a tank through a gravity sprinkler system to minimize spill potential. The pit drained through an oil/water separator into a holding tank and discharged to the sanitary sewer connected to the Publicly Owned Treatment Works at Fort Lewis (1982 CH2M Hill Installation Restoration Program Records Search). Fire training was stopped at this location in 1990 due to air emissions restrictions.

A Site Hazard Assessment under the terms of the Consent Decree with Ecology was conducted in 1993. Three test pits were excavated and soil samples were collected. All fuel-contaminated soil (6,000 cubic yards) discovered was removed and treated at an on-base landfarming facility (1997 USAF Fire Training Area Management Plan Addendum). During the excavation of soil, an UST was discovered and removed. During the removal of the tank, a fuel release occurred. Soil was removed at the location of the spill to a depth of 20 ft. Soils excavated from the FT-32 area were reportedly relocated to LF 13, approximately 0.2 mile south of FT 032, thereby creating an AOC at LF13 (see discussion below). Conformational soil samples were taken from below the UST and seven other locations across the pit. No fuel was detected in any of the samples. A Decision Document was written in August 1990, which indicated the site was finished and should be removed from further IRP consideration (1993 USAF IRP Response Action Carried Out at Site FT-32).

The new/current Fire Training Area FT-32 is constructed over the former Fire Training Area, and utilizes propane instead of jet fuel or other flammables/combustibles. The current Fire

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Training Area was permitted and is a regulated site. The training area pit now drains into an adjacent holding pond, and after inspection of the discharge and confirmation AFFF was not used, discharges to the sanitary sewer connected to the Publicly Owned Treatment Works at Fort Lewis.

Site MF-FT-33 McChord Field

Site MF-FT-33 is a former fire training area located adjacent to the current Fire Station House 105/Building 6. Fire training exercises were conducted at Site 33 from the late 1940s until 1950, when the overall airfield was much smaller than the current airfield. AVGAS was the primary fuel used during fire suppression training. Approximately 20 training exercises were conducted each year, and 100 to 200 gallons of aviation fuel were burned during each event. No information is available concerning soil seals or a water float. Small quantities of waste fuel were reportedly burned at the site and migration from the site was possible (1982 CH2M Hill Installation Restoration Program Records Search). The Air Force investigated the site and determined that this site posed no significant contamination threat and published a NFRAP Decision Document on 25 August 1993 (1993 USAF IRP NFA DD). Ecology notified the Air Force on 28 June 1995 that the site is identified as no further action/no further remedial action planned and published on the Hazardous Site List to inform the public that McChord remediated the site consistent with the Model Toxics Control Act, and that in its current setting the site no longer presents a danger to public health and is being monitored for environmental compliance.

Landfill 13 LF-13

Site LF-13 is an old landfill located on the up gradient of east side of the 700 feet southwest of the east gate and approximately 300 yards east of perimeter road. The site was used as landfill from 1950 until 1979. Open burning was reported to have occurred during the 1950's (1982 CH2M Hill Installation Restoration Program Records Search).

Currently the site covered with an engineered bioremediation facility. A 1990 site investigation was conducted using geophysical survey, soil gas survey, installation of three soil borings and 10 monitoring wells. Soil and groundwater samples were tested and all the analytical results were below the MTCA cleanup levels except TCE and daughter products detected slightly above cleanup level in both soil and groundwater samples. In 1993 the site was covered by an engineered and maintained bioremediation facility for fuel-contaminated soils excavated from other IRP sites, including soils excavated from MF-FT-27 and MF-FT-32. The facility has a 40 mil base of geo-fabric base upon which approximately 1.5 to 2.0 feet of fuel-contaminated soil has been placed. When the contaminated soils are fully bioremediated, the facility will either be dismantled or the remediated soil will be seeded with grass and used as permanent cap for the landfill (1993 USAF IRP NFA DD). Since soils from an FT 32 were moved to this location, it is an area of concern for PFAS which may have been leached from the bioremediation/landfarming facility.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Fire Training Pit FTLE17

Former Fort Lewis Fire Training Pit known as FTLE17 is located adjacent to the north side of Taxiway No. 2 at Gray Army Airfield. The FTLE17 is in a large, shallow swale approximately six feet below the elevation of the adjacent taxiway. A few yellow tires and remnants of a low berm (approx. 1.5 feet high) delineate the perimeter of the approximately 100 foot diameter pit. Between 1962 and 1982, the FTLE17 was used for air-crash rescue operation training. Waste materials including duplicating fluid, alcohol, paint thinner, and JP-4 were pumped into the pit and ignited as a fuel source. Records do not indicate whether or not all fluids pumped into the pit were consumed by burning (1993 USACE Multi-Site Limited Field Investigation Management Plan). In September of 1987, three borings were advanced to a depth of 10 feet. Eight soil samples were collected and analyzed for SVOCs, VOCs, pesticides and polychlorinated biphenyls, dioxins, and dioxin homologs. Trace amounts of dioxins, xylenes, methylene chloride, and some SVOCs were detected in some of the samples (U.S. Army 1990).

In 1993 three monitoring wells were installed to the depth of 40 feet bgs and groundwater samples were analyzed for SVOCs, VOCs, pesticides, polychlorinated biphenyls, dioxins, dioxin homologs and metals. All sample results were below their respective screening criteria and no evidence of groundwater contamination was observed (1995 USACE Multi-Site Limited Field Investigation Report). The location of FTLE17 is currently covered by a concrete surface and is part of a multi-acre aircraft ramp.

Based on their use as fire training areas, these sites are potential PFAS source areas.

Visual Site Inspections

The PA identified hangars at McChord Airfield and Gray Field that currently have, or historically have had, AFFF fire extinguishing systems. These hangars include McChord Hangars 1-7, 9-10, and 13; and Gray Field hangars 3063, 3098, 3106 and 3146; and temporary building 3099. Releases were identified at a number of the hangars by a variety of sources:

- Review of a spills database
- Reported by JBLM staff that escorted AECOM during our visits to the hangars, or staff that were interviewed after the visit
- During the visits site visits, ongoing small-scale releases of AFFF were also observed.

AFFF fire extinguishing systems have been activated and foam released at McChord Hangars 4 and 6. The release at Hangar 4 was approximately 3,000 gallons and the foam accumulated to a depth of approximately 20 feet on the hangar floor. The release of foam at Hangar 6 accumulated to a depth of approximately three feet on the hangar floor.

AFFF reservoirs in mechanical rooms have had releases occur, during which AFFF concentrate flowed to surrounding floor surfaces and in some cases discharged to floor drains, believed to be connected to the sanitary sewer system. These releases of foam concentrate occurred at

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

McChord Hangars 7 and 13; and Gray Field hangars 3063, 3098, 3106 and 3146; and Gray Field temporary building 3099. The volume of concentrate released ranges from one pint at hangar 3063 mechanical room to 1,500 gallons at McChord Hangar 13 mechanical room.

Two ongoing apparently low volume slow releases were observed during the visual site inspection at Hangars 6 and 10. Work orders regarding these observed releases were submitted to JBLM Public Works. Public Works responded immediately to the work orders.

Phase I Sample Results

Groundwater/surface water samples collected during the Phase I event were analyzed for the 14 PFAS compounds identified in Worksheet #11. As stated in Worksheet #11, the analytical concentrations of the 6 UCMR PFAS compounds were summed for each sample result and compared to the 70 ppt "screening level" to evaluate potential source areas. A summary of the results for each suspected source area evaluated during Phase I are provided below. Results are presented in Table 10-2 and shown on Figure 10-8. Phase I sample locations are shown on Figures 17-1 through 17-14 (JBLM 2018).

McChord Hangers, Runways, and Clover Creek

Thirteen groundwater samples and one surface water sample were collected within the immediate vicinity or downgradient of the McChord Hangars, runways, and Clover Creek. Groundwater samples were collected from monitoring wells: CW-62, CW-64, IW-2, CR-01, CW-14a, CW-14c, CW-14d, CW-15c, CW-15d, CW-29b, CW-4, MF-1, 1168-MW01, and LT-4. One surface water sample (Surface Water 1), was collected from within Clover Creek. Concentrations of the sum of six UCMR 3 compounds in groundwater collected from this set of monitoring wells ranged from 2.86 ppt (CW-15d) to 973 ppt (CW-15c). Surface Water 1 reported a concentration (six UCMR 3 compounds) of 35.69 ppt. Nine of the 13 samples have a sum of the 6 UCMR-3 compounds at concentrations greater than the HAL of 70 ppt. These summed concentrations range from 112.7 to 973.3 ppt.

Fire Training Area FT029, FT032, and Landfill 13

Seven groundwater samples were collected from existing monitoring wells to assess potential sources associated with fire training areas FT029, FT032, and Landfill 13. Groundwater samples were collected from monitoring wells: CW-12, FTA-4a, FTA-4b, IH-1a, IH-1b, IH-3b, IH-3c, and CW-33c. The sum of the 6 UCMR-3 compounds for samples collected from monitoring wells within FTA032 ranged from 22,089 ppt (FTA-4a) to 37,170 ppt (FTA-4b). The sum of six UCMR-3 compounds for samples collected from monitoring wells associated with Landfill 13 ranged from non-detect (IH-1a) to 2,653 ppt (IH-3b). The groundwater sample from monitoring well CW-12 associated with fire training area FT029 had a reported concentration of 39.2 ppt. Existing monitoring well CW-33c located down/cross-gradient of fire training area FT032 and Landfill 13 was sampled and had a reported concentration of 24 ppt.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Landfills 005 and 006

Six groundwater samples were collected from existing monitoring wells associated with Landfills 0005 and 006. Samples were collected from monitoring wells: DA-21e, DA-7e, DO-2, DO-5b, DA-4a, and DA-4b. The sum of six UCMR-3 compounds in groundwater collected from these monitoring wells ranged from 0 ppt (DA-7e) to 81 ppt (DO-5b).

Landfill #2

Eight groundwater samples were collected from existing monitoring wells and treatment systems associated with Landfill #2. Monitoring wells LC-153, LC-230 and treatment systems samples LF-2 P&T Influent, LF-2 P&T Effluent, I-5 P&T Influent, I-5 P&T Effluent, SLA P&T Influent, and SLA P&T Effluent were sampled. The sum of six UCMR-3 compounds in groundwater collected from these monitoring wells and treatment systems ranged from 2.35 ppt (LF-2 P&T Effluent) to 65.36 ppt (I-5 P&T Effluent).

Gray Field Hangars, Landfill #1, and SWMU47

Two groundwater samples were collected from existing monitoring wells associated Landfill #1 (wells 84-CD-LF1-1 and 84-CD-LF1-4) and one sample was collected from an existing well associated with SWMU47 (98-IA-MW08). The sum of six UCMR-3 compounds in groundwater collected from these wells ranged from 3.41 ppt (84-CD-LF1-4) to 21.51 ppt (98-IA-MW-08).

Historic waterproofing and laundry operations

Two groundwater samples were collected from existing monitoring wells 4131-MW04 and 01035-MW01, located adjacent to former waterproofing and laundry operations. The sum of six UCMR-3 compounds in groundwater collected from 4131-MW04 and 01035-MW01 were 61.30 ppt and 169.3 ppt, respectively.

Landfill #4

Three groundwater samples were collected from existing monitoring wells located within Landfill #4: LF4-01, LF4-MW-10, and LF4-PNL1. The sum of six UCMR-3 compounds in groundwater collected from these wells ranged from 12.50 ppt (LF4-PNL1) to 19.28 ppt (LF4-01).

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

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QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Table 10-1 Phase I PFAS Results Summary Table

Well ID	Nearest Drinking Water Well	Figure Reference	Date Collected	NEtFOSAA (ng/L)	NMeFOSAA (ng/L)	PFBS (ng/L)	PFDA (ng/L)	PFDoA (ng/L)	PFHpA (ng/L)	PFHxS (ng/L)	PFHxA (ng/L)	PFNA (ng/L)	PFOS (ng/L)	PFOA (ng/L)	PFTA (ng/L)	PFTrDA (ng/L)	PFUnA (ng/L)	Sum of 6 UCMR PFAS Compounds[d] (ng/L)
Project Action Limit[a]				NE	NE	400,000[b]	NE	NE	NE	NE	NE	NE	70[c]	70[c]	NE	NE	NE	70
Clover Creek																		
CW-62	North Well	17-3	6/19/2018	0.88 U	0.88 U	**9.2**	0.88 U	0.26 U	**4.5**	**33**	**7.1**	**0.71 J**	**60**	**7.4**	0.53 U	0.53 U	0.35 U	114.81
Clover Creek and McChord Hangars																		
CW-64	North Well	17-2, 17-3	6/19/2018	0.86 U	0.86 U	**4.1**	0.86 U	0.26 U	**6.4**	**9.6**	**5.8**	**1.4 J**	**34**	**23**	0.51 U	0.51 U	0.34 U	78.50
IW-2	North Well	17-2, 17-3	6/8/2018	0.91 U	0.91 U	**23**	0.91 U	0.27 U	**2.0**	**8.7**	**2.3 J**	0.36 U	**3.1**	**5.7**	0.54 U	0.54 U	0.36 U	42.86
FT029																		
CW-12	East Well	17-5	6/7/2018	1.7 U	1.7 U	**3.9**	1.7 U	0.50 U	0.50 U	**4.2**	1.7 U	0.67 U	**24**	**7.1**	1.0 U	1.0 U	0.67 U	40.37
FT032																		
FTA-4a	East Well	17-6	6/7/2018	9.1 U	9.1 U	**81**	9.1 U	2.7 U	**290**	**2,000**	**390**	**88**	**19,000**	**630**	5.5 U	5.5 U	3.6 U	22,089.00
FTA-4b	East Well	17-6	6/7/2018	9.1 U	9.1 U	**630**	**33**	2.7 U	**650**	**5,900**	**1,700**	**590**	**28,000**	**1,400**	5.5 U	5.5 U	**13 J**	37,170.00
Historic waterproofing, laundry																		
01035-MW01	Well 17	17-12	6/18/2018	0.88 U	0.88 U	**5.7**	0.88 U	0.26 U	**12**	**40**	**31**	**3.6**	**82**	**26**	0.53 U	0.53 U	0.35 U	169.30
4131-MW04	Well 17	17-12	6/18/2018	0.88 U	0.88 U	**4.6**	0.88 U	0.27 U	**5.3**	**15**	**6.1**	**1.4 J**	**23**	**12**	0.53 U	0.53 U	0.35 U	61.30
			6/18/2018 (DUP)	0.90 U	0.90 U	**4.5**	0.90 U	0.27 U	**4.8**	**15**	**5.9**	**1.2 J**	**22**	**11**	0.54 U	0.54 U	0.36 U	58.50
Landfill #1/Gray Field Hangars/SWMU 47																		
84-CD-LF1-1	Well 14	17-10	6/26/2018	0.87 U	0.87 U	**0.80 J**	0.87 U	0.26 U	0.26 U	**1.7 J**	0.87 U	0.35 U	**1.4 J**	**0.27 J**	0.52 U	0.52 U	0.35 U	4.78
84-CD-LF1-4	Well 14	17-10	6/26/2018	0.89 U	0.89 U	**0.36 J**	0.89 U	0.27 U	0.27 U	**1.2 J**	0.89 U	0.36 U	**0.85 J**	**0.37 J**	0.54 U	0.54 U	0.36 U	3.41
Landfill #2																		
I-5 P&T Effluent	MAMC-04	17-11	6/18/2018	0.86 U	0.86 U	**2.1**	0.86 U	0.26 U	**1.7**	**20**	**4.1**	**0.56 J**	**31**	**10**	0.51 U	0.51 U	0.34 U	65.36
I-5 P&T Influent	MAMC-04	17-11	6/18/2018	0.87 U	0.87 U	**2.1**	0.87 U	0.26 U	**1.7 J**	**20**	**3.9**	**0.52 J**	**29**	**10**	0.52 U	0.52 U	0.35 U	63.32
LC-153	MAMC-04/Sage Well II	17-9	6/26/2018	0.88 U	0.88 U	0.26 U	0.88 U	0.26 U	0.26 U	0.35 U	0.88 U	0.35 U	0.53 U	**0.73 J**	0.53 U	0.53 U	0.35 U	2.48
LC-230	MAMC-04/Sage Well II	17-9	6/15/2018	0.90 U	0.90 U	**3.0**	0.90 U	0.27 U	**0.66 J**	**4.6**	**6.4**	0.36 U	0.54 U	**0.38 J**	0.54 U	0.54 U	0.36 U	9.54
LF-2 P&T Effluent	MAMC-04	17-9	6/18/2018	0.88 U	0.88 U	0.26 U	0.88 U	0.26 U	0.26 U	**0.59 J**	0.88 U	0.35 U	0.53 U	**0.36 J**	0.53 U	0.53 U	0.35 U	2.35
LF-2 P&T Influent	MAMC-04	17-9	6/18/2018	0.85 U	0.85 U	**1.0 J**	**5.6**	**0.27 J**	**1.6 J**	**3.9**	**2.8**	**3.0**	**9.1**	**9.9**	0.51 U	0.51 U	**2.1**	28.50
SLA P&T Effluent	MAMC-04	17-11	6/18/2018	0.85 U	0.85 U	**0.74 J**	0.85 U	0.26 U	**0.42 J**	**4.1**	**1.1 J**	0.34 U	**4.8**	**4.7**	0.51 U	0.51 U	0.34 U	15.10
SLA P&T Influent	MAMC-04	17-11	6/18/2018	0.88 U	0.88 U	**0.80 J**	0.88 U	0.26 U	**0.48 J**	**4.4**	**1.2 J**	0.35 U	**5.7**	**5.0**	0.53 U	0.53 U	0.35 U	16.73
Landfill #4																		

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Table 10-1 Phase I PFAS Results Summary Table (continued)

Well ID	Nearest Drinking Water Well	Figure Reference	Date Collected	NEtFOSAA (ng/L)	NMeFOSAA (ng/L)	PFBS (ng/L)	PFDA (ng/L)	PFDoA (ng/L)	PFHpA (ng/L)	PFHxS (ng/L)	PFHxA (ng/L)	PFNA (ng/L)	PFOS (ng/L)	PFOA (ng/L)	PFTA (ng/L)	PFTrDA (ng/L)	PFUnA (ng/L)	Sum of 6 UCMR PFAS Compounds[d] (ng/L)
Project Action Limit[a]				**NE**	**NE**	**400,000[b]**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**70[c]**	**70[c]**	**NE**	**NE**	**NE**	**70**
LF4-01	Sequalitchew Springs/Well 12B	17-13	6/20/2018	0.91 U	0.91 U	**3.5**	0.91 U	0.27 U	**0.32 J**	**3.9**	0.91 U	0.36 U	**5.3**	**5.9**	0.54 U	0.54 U	0.36 U	19.28
LF4-MW-10	Sequalitchew Springs/Well 12B	17-13	6/20/2018	1.3 U	1.3 U	**3.7**	1.3 U	0.38 U	0.38 U	**3.0**	1.3 U	0.50 U	**4.0**	**2.3 J**	0.75 U	0.75 U	0.50 U	13.88
LF4-PNL1	Sequalitchew Springs/Well 12B	17-13	6/26/2018	0.90 U	0.90 U	**2.4**	0.90 U	0.27 U	**0.34 J**	**3.1**	0.90 U	0.36 U	**3.6**	**2.7**	0.54 U	0.54 U	0.36 U	12.50
Landfill 005																		
DA-21a	MARS Hill	17-8	6/14/2018	0.90 U	0.90 U	**2.6**	0.90 U	0.27 U	**1.2 J**	**14**	**2.2 J**	**0.56 J**	**20**	**2.9**	0.54 U	0.54 U	0.36 U	41.26
DA-7e	MARS Hill	17-8	6/14/2018	2.5 U	2.5 U	0.74 U	2.5 U	0.74 U	0.74 U	0.99 U	2.5 U	0.99 U	1.5 U	0.74 U	1.5 U	1.5 U	0.99 U	ND
DO-2	Housing Well I	17-8	6/14/2018	0.91 U	0.91 U	**2.9**	0.91 U	0.27 U	**2.2**	**16**	**4.4**	0.36 U	**17**	**4.0**	0.55 U	0.55 U	0.36 U	42.46
DO-5b	Housing Well I	17-8	6/14/2018	0.91 U	0.91 U	**4.1**	0.91 U	0.27 U	**3.6**	**29**	**7.4**	**0.56 J**	**38**	**5.6**	0.54 U	0.54 U	0.36 U	80.86
Landfill 005/006																		
DA-4a	Sage Well I	17-14	6/13/2018	0.90 U	0.90 U	**0.68 J**	0.90 U	0.27 U	**0.94 J**	**3.7**	**1.9 J**	0.36 U	**7.1**	**1.9**	0.54 U	0.54 U	0.36 U	14.68
DA-4b	Sage Well I	17-14	6/13/2018	0.91 U	0.91 U	**0.74 J**	0.91 U	0.27 U	0.27 U	**4.0**	0.91 U	0.36 U	**3.4**	0.27 U	0.54 U	0.54 U	0.36 U	9.04
Landfill 013																		
IH-1a	East Well	17-6	6/7/2018	0.91 U	0.91 U	0.27 U	0.91 U	0.27 U	0.27 U	0.36 U	0.91 U	0.36 U	0.55 U	0.27 U	0.55 U	0.55 U	0.36 U	ND
IH-1b	East Well	17-6	6/7/2018	0.92 U	0.92 U	**0.30 J**	0.92 U	0.27 U	0.27 U	**0.47 J**	0.92 U	0.37 U	**2.0 J**	0.27 U	0.55 U	0.55 U	0.37 U	3.68
IH-3b	East Well	17-6	6/12/2018	0.89 U	0.89 U	**51**	0.89 U	0.27 U	**57**	**930**	**280**	**30**	**1,200**	**210**	0.54 U	0.54 U	0.36 U	2,478.00
IH-3c	East Well	17-6	6/26/2018	0.85 U	0.85 U	**62**	0.85 U	0.26 U	**70**	**1,000**	**360**	**21**	**740**	**760**	0.51 U	0.51 U	0.34 U	2,653.00
			6/26/2018 (DUP)	0.86 U	0.86 U	**61**	0.86 U	0.26 U	**64**	**1,000**	**340**	**20**	**720**	**720**	0.52 U	0.52 U	0.35 U	2585.00
Landfill 013/FT032																		
CW-33c	Prime Beef Replacement Well I	17-7	6/12/2018	0.91 U	0.91 U	**2.9**	0.91 U	0.27 U	**0.33 J**	**9.3**	**1.0 J**	0.36 U	**11**	**0.59 J**	0.54 U	0.54 U	0.36 U	24.48
McChord Hangars, Runways and Clover Creek																		
CR-01	North Well	17-2	6/11/2018	0.89 U	0.89 U	**5.5**	**1.1 J**	0.27 U	**6.5**	**45**	**14**	**1.1 J**	**57**	**7.6**	0.53 U	0.53 U	0.36 U	122.70
CW-14a	South Well	17-4	6/6/2018	0.92 U	0.92 U	**10**	**1.5 J**	0.28 U	**14**	**54**	**37**	**1.5 J**	**44**	**16**	0.55 U	0.55 U	0.37 U	139.50
CW-14c	South Well	17-4	6/11/2018	1.7 U	1.7 U	**17**	1.7 U	0.50 U	**17**	**88**	**27**	**2.0 J**	**200**	**16**	1.0 U	1.0 U	0.67 U	340.00
CW-14d	South Well	17-4	6/11/2018	0.89 U	0.89 U	**9.1**	0.89 U	0.27 U	**6.3**	**42**	**12**	**0.60 J**	**95**	**6.6**	0.54 U	0.54 U	0.36 U	159.60
			6/11/2018 (DUP)	0.90 U	0.90 U	**8.4**	0.90 U	0.27 U	**6.4**	**42**	**12**	**0.60 J**	**96**	**6.5**	0.54 U	0.54 U	0.36 U	159.90
CW-15c	North Well	17-4	6/6/2018	0.91 U	0.91 U	**29**	0.91 U	0.27 U	**48**	**210**	**91**	**3.3**	**640**	**43**	0.54 U	0.54 U	0.36 U	973.30
CW-15d	North Well	17-4	6/6/2018	0.91 U	0.91 U	0.27 U	0.91 U	0.27 U	0.27 U	**0.69 J**	0.91 U	0.36 U	**1.0 J**	0.27 U	0.54 U	0.54 U	0.36 U	2.86

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Table 10-1 Phase I PFAS Results Summary Table (continued)

Well ID	Nearest Drinking Water Well	Figure Reference	Date Collected	NEtFOSAA (ng/L)	NMeFOSAA (ng/L)	PFBS (ng/L)	PFDA (ng/L)	PFDoA (ng/L)	PFHpA (ng/L)	PFHxS (ng/L)	PFHxA (ng/L)	PFNA (ng/L)	PFOS (ng/L)	PFOA (ng/L)	PFTA (ng/L)	PFTrDA (ng/L)	PFUnA (ng/L)	Sum of 6 UCMR PFAS Compounds [d] (ng/L)
Project Action Limit[a]				**NE**	**NE**	**400,000[b]**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**70[c]**	**70[c]**	**NE**	**NE**	**NE**	**70**
			6/6/2018 (DUP)	0.91 U	0.91 U	0.27 U	0.91 U	0.27 U	0.27 U	**0.57 J**	0.91 U	0.37 U	**0.85 J**	**0.29 J**	0.55 U	0.55 U	0.37 U	2.62
CW-29b	North Well	17-2	6/12/2018	0.90 U	0.90 U	**9.5**	**2.8**	0.27 U	**7.0**	**65**	**15**	**1.7 J**	**89**	**11**	0.54 U	0.54 U	0.36 U	183.20
CW-4	North Well	17-3	6/19/2018	0.89 U	0.89 U	**0.36 J**	0.89 U	0.27 U	0.27 U	**1.1 J**	0.89 U	0.36 U	0.53 U	0.27 U	0.53 U	0.53 U	0.36 U	2.89
MF-1	North Well	17-2	6/19/2018	1.7 U	1.7 U	**17**	**2.1 J**	0.50 U	**49**	**200**	**96**	**5.2**	**310**	**37**	1.0 U	1.0 U	0.67 U	618.20
Surface Water 1	North Well	17-2	6/8/2018	0.92 U	0.92 U	**4.5**	0.92 U	0.27 U	**1.3 J**	**6.2**	**2.6 J**	**0.49 J**	**19**	**4.2**	0.55 U	0.55 U	0.37 U	35.69
			6/8/2018 (DUP)	0.90 U	0.90 U	**4.2**	0.90 U	0.27 U	**1.2 J**	**5.5**	**2.5 J**	**0.47 J**	**18**	**3.8**	0.54 U	0.54 U	0.36 U	33.17
North McChord Hangars and Runways																		
1168-MW01	North Well	17-1	6/12/2018	0.89 U	0.89 U	**3.0**	**6.9**	0.27 U	**190**	**56**	**220**	**13**	**50**	**71**	0.54 U	0.54 U	0.36 U	383.00
LT-4	North Well	17-1	6/13/2018	0.90 U	0.90 U	**3.1**	0.90 U	0.27 U	**1.1 J**	**11**	**1.5 J**	0.36 U	**17**	**1.6 J**	0.54 U	0.54 U	0.36 U	34.16
SMWU 47																		
98-IA-MW-08	Well 20	17-10	6/18/2018	0.87 U	0.87 U	0.26 U	0.87 U	0.26 U	**1.9**	**2.3**	**1.2 J**	0.35 U	**15**	**1.7 J**	0.52 U	0.52 U	0.35 U	21.51
Statistical Summary																		
Number of Analyses				50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Number of Detections above reporting limit				0	0	43	7	1	37	47	35	26	44	44	0	0	2	48
Maximum Detection				0	0	630	33	0.27	650	5,900	1,700	590	28,000	1,400	0	0	13	37,170
Minimum Detection				0	0	0.3	1.1	0.27	0.32	0.47	1	0.47	0.85	0.27	0	0	2.1	2.35
Average Detection				0	0	25.5	7.6	0.27	41.4	253.9	105.6	30.5	1,176.2	93.3	0	0	7.6	1,483.9
																	Number of Detections with Sum of 6 UCMR PFAS Compounds Greater than 70 ppt	18
Field Rinsate Blanks																		
FRB1			6/6/2018	0.91 U	0.91 U	0.27 U	0.91 U	0.27 U	0.27 U	0.36 U	0.91 U	0.36 U	0.55 U	0.27 U	0.55 U	0.55 U	0.36 U	ND
FRB2			6/7/2018	0.92 U	0.92 U	0.28 U	0.92 U	0.28 U	0.28 U	0.37 U	0.92 U	0.37 U	0.55 U	0.28 U	0.55 U	0.55 U	0.37 U	ND
FRB3			6/8/2018	0.90 U	0.90 U	0.27 U	0.90 U	0.27 U	0.27 U	0.36 U	0.90 U	0.36 U	0.54 U	0.27 U	0.54 U	0.54 U	0.36 U	ND
FRB4			6/11/2018	0.89 U	0.89 U	0.27 U	0.89 U	0.27 U	0.27 U	0.36 U	0.89 U	0.36 U	0.53 U	0.27 U	0.53 U	0.53 U	0.36 U	ND
FRB5			6/12/2018	0.89 U	0.89 U	0.27 U	0.89 U	0.27 U	0.27 U	0.36 U	0.89 U	0.36 U	0.53 U	0.27 U	0.53 U	0.53 U	0.36 U	ND
FRB6			6/13/2018	0.91 U	0.91 U	0.27 U	0.91 U	0.27 U	0.27 U	0.36 U	0.91 U	0.36 U	0.54 U	0.27 U	0.54 U	0.54 U	0.36 U	ND
FRB7			6/14/2018	0.91 U	0.91 U	0.27 U	0.91 U	0.27 U	0.27 U	0.36 U	0.91 U	0.36 U	0.54 U	0.27 U	0.54 U	0.54 U	0.36 U	ND
FRB8			6/18/2018	0.90 U	0.90 U	0.27 U	0.90 U	0.27 U	0.27 U	0.36 U	0.90 U	0.36 U	0.54 U	0.27 U	0.54 U	0.54 U	0.36 U	ND
FRB9			6/19/2018	0.85 U	0.85 U	0.26 U	0.85 U	0.26 U	0.26 U	0.34 U	0.85 U	0.34 U	0.51 U	0.26 U	0.51 U	0.51 U	0.34 U	ND
FRB10			6/20/2018	0.89 U	0.89 U	0.27 U	0.89 U	0.27 U	0.27 U	0.35 U	0.89 U	0.35 U	0.53 U	0.27 U	0.53 U	0.53 U	0.35 U	ND
FRB11			6/26/2018	0.89 U	0.89 U	0.27 U	0.89 U	0.27 U	0.27 U	0.35 U	0.89 U	0.35 U	0.53 U	0.27 U	0.53 U	0.53 U	0.35 U	ND

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Table 10-1 Phase I PFAS Results Summary Table (continued)

Notes:

[a]Fact Sheet PFOA & PFOS Drinking Water Health Advisories. EPA 800-F-16-003, November 2016 (US EPA 2016c). Guidance provides a health advisory level of 70 ppt for PFOS and PFOA. If both PFOS and PFOA are found to be present, the concentrations of both PFAS combined will be compared to the value of 70 ppt.

[b]Based on US EPA Regional Screening Levels (RSLs) (US EPA, 2017).

[c]EPA Health Advisory Level

[d]Sum of detections for PFOS, PFOA, PFBS, PFHpA, PFHxS, and PFNA.

Values in **bold** font indicate the compound was reported as detected.

Indicates the concentration is at or exceeds the project action limit.

Sum of 6 UCMR PFAS compounds greater than 70 ppt

UCMR Compound

DUP - Field duplicate

J - Estimated value

ND - Not detected

NE - Not established

ng/L - nanogram per liter

NMeFOSAA - N-methyl perfluorooctanesulfonamidoacetic acid

PFAS - Per- and polyflouralkyl substances

PFBS - Perfluorobutanesulfonate

PFDA - Perfluorodecanoic acid

PFDoA - Perfluorododecanoic acid

PFHpA - Perfluoroheptanoic acid

PFHxA - Perfluorohexanoic acid

PFHxS - Perfluorohexanesulfonate

PFNA - Perfluorononanoic acid

PFOA - Perfluorooctanoic acid

PFOS - Perfluoro-octanesulfonate

PFTA - Perfluorotetradecanoic acid

PFTrDA - Perfluorotridecanoic acid

PFUnA - Perfluoroundecanoic acid

U - Analyte was not detected above the practical quantitation limit shown.

UCMR - Unregulated Contaminant Monitoring Rule

UJ - Analyte was not detected above the practical quantitation limit shown. The practical quantitation limit is an estimated value.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

Please refer to the JBLM 2018 for Figure 10-1 through 10-7.

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

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LT-4 33.5
1168-MW01 383
CW-62 114.81
CW-64 78.5
SW-1 35.69 (33.17)
CR-01 123
CW-4 1.46
W-2 42.5
CW-15C 973.3
CW-29B 183
MF-1 618.2
CW-12 39.2
North Well
CW-15D 1.69 (1.71)
CW-14A 139.5
South Well
CW-14C 340
CW-14D 159.60 (159.90)
FTA-4A 22,089
East Well
FTA-4B 37,170
CW-33C 24
IH-3B 2,478
IH-3C 2,653 (2,585)
IH-1B 2.77
IH-1A 6
Housing Well II
Housing Well III
Housing Well I
DO-2 42.1
DO-5B 61
DA-21A 41.3
DA-7E 0
MARS Hill
Sage Well II
Sage Well I
DA-4B 8.1
DA-4A 14.3
Replacement Well II
LF4-MW-10 13
LF4-PNL1 12.14
LF4-01 16.92
Sequalitchew Spring
Well 12B
Well 12A
LS-Effluent 65.36
LS-Influent 63.32
SLA-Effluent 14.76
SLA-Influent 16.38
MAMC-04
Well 13
LC-230 8.6
LC-153 0.73
LF-2-Effluent 0.95
LF-2-Influent 28.5
Well 10
Well 23
Well 22
Well 17
4131-MW04 61.30 (58.50)
01035-MW01 169.3
Well 14
Well 20
84-CD-LFI-1 4.17
84-CD-LFI-4 2.75
98-IA-MW08 20.9

Legend

Phase 1 Sampling Results - Vashon Aquifer
- <70ppt
- 70ppt - 200ppt
- 200ppt - 1,000ppt
- >1,000ppt

Phase 1 Sampling Results - Sea Level Aquifer
- <70ppt
- 70ppt - 200ppt

JBLM Production Wells ppt - Sum of PFOS and PFOA only
- 0 - 5
- 6 - 30
- 31 - 70
- 71 - 140
- 141 - 251

Monitoring Wells
- Existing Monitoring Wells
- Monitoring Wells Selected for Phase 1 Sampling
- Surface Water Sample Locations
- JBLM Boundary
- 10-Year WHPA/Capture Zones

CW-15D 1.69 (1.71) — Well ID, 6 UCMR Compounds Summed Concentration (ng/L)*

*Concentration in Parenthesis Notes Duplicate Sample

N

0 0.25 0.5 1 Miles

Figure 10-8
Phase I Sample Results

Joint Base Lewis McChord
Lakewood, WA

Document Path: J:\DCS\Projects\ENV\60555402_JBLM_PASI\900-CAD-GIS\940-GIS\MXDs\Phase_1_Sampling_Results_v2.mxd

Aerial Sources: JBLM Public Works 2016_UTM10_NAD83_NAVD88.sid

QAPP Worksheet #10 -- Problem Definition/Preliminary Conceptual Site Model (Continued)

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QAPP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements

Data quality objectives are an integrated set of qualitative and quantitative decision statements that define data quality requirements based on the end use of the data. The EPA has developed a seven-step process to clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

This amendment includes Phase II sampling under Task Order W912DW17F2085 and additional well installation under TO W912DW18F2107. The additional well installation is considered to be part of the PASI source identification and the project quality objectives remain unchanged. The specific locations and rationale for the Phase II samples and additional wells are described in Worksheet #s 17 and 18.

Step 1: State the problem. This step identifies the issues to be addressed.

Problem statement: "Five water production wells have detected the sum of PFOS and PFOA at concentrations greater than the EPA LHA of 70 ppt."

Step 2: Identify the decision. This step is to define the decision that will be made using data to address the problem. This QAPP will conservatively add the full 6 UCMR compounds and compare that sum against a 70 ppt "screening level" to identify the need for further evaluation relative to evaluated source areas. This is being done in anticipation of Washington State regulations that are believed to be a sum of more than just PFOS and PFOA that will be compared against a 70 ppt level. Identification and assessment of potential PFOS/PFOA source areas as prescribed herein may be adjusted at a future date based on the specific PFAS-compound related criteria that Washington State issues. The overall decisions to be made based on the data collected under this QAPP are as follows:

1. If the total concentration of PFOS, PFOA, and 4 other specific PFAS compounds in a groundwater sample is above 70 ppt, then the associated potential source area will require further evaluation. The six PFAS compounds are:
    - Perfluorooctanesulfonic Acid (PFOS)
    - Perfluorooctanic Acid (PFOA)
    - Perfluorobutanesulfonic Acid (PFBS)
    - Perfluoroheptanoic Acid (PFHpA)
    - Perfluorohexanesulfonic Acid (PFHxS)
    - Perfluorononanoic Acid (PFNA)

QAPP Worksheet #11 – Project Quality Objectives/Systematic Planning Process (Continued)

2. If the total PFAS concentrations of these six PFAS compounds in all groundwater samples for a potential source area are below 70 ppt, then the associated potential source area will not require further evaluation at this time.

Step 3: Identify the inputs to the decision. Inputs to the decision will consist of the following:

- Results of the Preliminary Assessment (PA)
- Prioritization of the source areas identified during the PA
    - AFFF application, spills, and storage
    - Waterproofing and surfactant operations
    - Landfills
- Site hydrogeology and existing capture zones/wellhead protection areas
- Existing analytical data collected from the drinking water production wells
- Phase I analytical sampling results
- Phase II analytical sampling results
- Comparison of analytical results to the EPA HAL

Step 4: Define the site boundaries. The spatial boundaries of the site are shown on Figure 11-1. At this time, the site boundaries are the installation boundaries. Individual site boundaries within the installation may be refined over time.

Step 5: Develop a decision rule. The process or "rules" for making the decisions listed under Step 2 are described in this section. Rules include how field decisions will be made, as well as how data will be interpreted.

Groundwater/surface water samples will be collected from 45 locations during the Phase I event. Results of Phase I will be used by the Technical Project Team to guide the Phase II well installation and sampling location selection. The areas with the highest concentration of detections in Phase I samples will be prioritized in Phase II. Up to 15 new wells or 950 linear feet of total well construction and sampling from 20 locations will be conducted during Phase II.

Decision 1 - If the total PFAS concentration of six UCMR compounds in a groundwater sample is above 70 ppt, then the associated potential source area will require further evaluation.

1. Collect groundwater and surface water samples during Phase I and II and analyze for 14 PFAS compounds.
2. Compare the analytical results to the EPA HAL of 70 ppt to make Decision 1.
3. "U" qualified result (not detected above the specified practical quantitation limit [PQL] will be assigned one-half the value of the PQL.

QAPP Worksheet #11 – Project Quality Objectives/Systematic Planning Process (Continued)

Decision 2 - If the total PFAS concentrations of six UCMR-3 compounds in all groundwater samples for a potential source area are below 70 ppt, then the associated potential source area will not require further evaluation at this time.

1. Collect groundwater and surface water samples during Phase I and II and analyze for 14 PFAS compounds.
2. Compare the analytical results to the EPA LHA of 70 ppt to make Decision 2.
3. "U" qualified result (not detected above the specified practical quantitation limit [PQL] will be assigned one-half the value of the PQL.

Step 6: Specify limits on decision errors. The investigation will use decision-error minimization techniques in sampling design, sampling methodologies, and laboratory measurements. Possible decision errors will be minimized during the field investigation by using the following methods:

Use PFAS-specific field sampling methodologies (as discussed in Worksheets #14 and #21).

Use applicable analytical methods and SOPs for sample analysis by a competent analytical laboratory.

The selected laboratory may change over the course of the project. A laboratory with a current DoD ELAP certification must be used for groundwater samples as specified in Worksheet #28.

Confirm analytical data to identify and control potential laboratory error and sampling error by using spikes, blanks, and duplicate samples as summarized in Worksheets #12, #18, #20, and #28.

Field screening of the groundwater parameters is a standard procedure in the development and sampling of wells. Field screening of the groundwater parameters shall be of sufficient quality to determine whether the aquifer has stabilized so that samples collected represent actual aquifer characteristics.

All sample information will be transcribed into a field logbook and/or onto field data sheets.

AECOM will provide data validation services and verify and evaluate the usability of the data as described in Worksheets #34 through #36. AECOM chemists experienced with PFAS validation will participate in the process.

Step 7: Optimize the sampling design. The results of the Phase I sampling event will be used to optimize Phase II the well installation and sample locations selected for Phase II.

QAPP Worksheet #11 – Project Quality Objectives/Systematic Planning Process (Continued)

Table 11-1 Groundwater Screening Levels and PRQLs

Chemical	Screening Level[a] (ppt)	PRQL[b] (ppt)
N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA)	NE	7
N-methyl perfluorooctanesulfonamidoacetic acid (NMeFOSAA)	NE	7
Perfluorobutanesulfonic acid (PFBS)	400,000[b]	20,000
Perfluorodecanoic acid (PFDA)	NE	7
Perfluorododecanoic acid (PFDoA)	NE	7
Perfluoroheptanoic acid (PFHpA)	NE	7
Perfluorohexanesulfonic acid (PFHxS)	NE	7
Perfluorohexanoic acid (PFHxA)	NE	7
Perfluorononanoic acid (PFNA)	NE	7
Perfluorooctanesulfonic acid (PFOS)	70[c]	7
Perfluorooctanoic acid (PFOA)	70[c]	7
Perfluorotetradecanoic acid (PFTA)	NE	7
Perfluorotridecanoic acid (PFTrDA)	NE	7
Perfluoroundecanoic acid (PFUnA)	NE	7

[a]Source: EPA's lifetime health advisories for PFOS and PFOA and tapwater RSL for PFBS (EPA 2016 a, b)
[b]Based on US EPA Regional Screening Levels (RSLs) (US EPA, 2017).
[c]Fact Sheet PFOA & PFOS Drinking Water Health Advisories. EPA 800-F-16-003, November 2016 (EPA 2016c). Guidance provides a health advisory level of 70 ppt for PFOS and PFOA. If both PFOS and PFOA are found to be present, the concentrations of both PFAS combined will be compared to the value of 70 ppt.

Notes:
EPA – [U.S.] Environmental Protection Agency
NE – not established
ppt – parts per trillion
PRQL – project-required quantitation limit
RSL – regional screening level

QAPP Worksheet #14 -- Summary of Project Tasks

Phase II Installation of Supplemental Monitoring Wells

1. Establish planned well installation locations shown on Figure 17-15 through 17-26 and mark proposed drilling locations with white marking paint.
2. Conduct utility locate.
3. Mobilize sonic drill rig to borehole location.
4. Advance borings using sonic drill methods to the approximate depths presented in Worksheet #s 17 and 18 of this Addendum.
5. Log soil lithology and field-screen soil samples for organic vapors using a photoionization detector (PID).
6. Construct new monitoring wells as described in Worksheet #17 of this Addendum.
7. Complete surface of each monitoring well location (e.g. install protective monument and concrete pad) as described in Worksheet #17.
8. Collect well locations, top-of-casing elevations, and ground surface elevations using the land surveying techniques described in SOP K.

Phase II Groundwater Sampling

1. Collect groundwater samples from well identified in Worksheet #18 of this QAPP Addendum using low-flow methods described in SOP B.

Analysis Tasks

1. Groundwater samples will be analyzed by Eurofins Lancaster Laboratory (ELLE) for the 14 PFAS compounds identified in EPA Method 537 modified. Refer to Worksheet #23 for analytical method details.

Quality Control Tasks

1. Implement SOPs for PFAS sampling, related field tasks, and sample preparation/analysis methods.
2. Field quality control samples are described in Worksheet #12. Laboratory analytical quality control samples are described in Worksheet #28.
3. Analytical laboratory data for the 14 PFAS compounds will be submitted for 100% independent data validation, which will be documented in a data validation report(s).

Secondary Data

1. 2017/2018 drinking water production well sampling data collected by the JBLM Public Works Department will be used in evaluating source areas and in selecting Phase II sampling locations.

QAPP Worksheet #14 -- Summary of Project Tasks (Continued)

Data Management Tasks

1. Analytical data and boring logs as PDFs (if feasible) will be loaded into the JBLM electronic database following validation as directed by the JBLM PM.
2. Original hard copies of the analytical data packages and data validation reports will be submitted to the JBLM for archive.
3. Original hard-copy field data will be retained in the secure central project file, and photocopies will be used for data-reduction project work.

Documentation and Records

1. Field data will be recorded in a bound logbook and on lithologic borehole log forms as described in SOP L.
2. Logbooks, chains-of-custody, air-bills, and other hard-copy field records will be retained in the AECOM project file. Pertinent copies will also be appended to the report.

Data Packages

1. Laboratory data will be recorded in a Contract Laboratory Program or similar format, including sample identification, analysis date, parameter values, method detection limits, and reporting limits. Laboratory data reports must include all information required to perform a comprehensive data validation. The data package elements required to perform data validation are listed below and will include both summary forms and instrumental printouts as applicable:
    - Initial calibration
    - Initial calibration verification
    - Continuing calibration verification
    - Blank spike results and control charts
    - Results from initial calibration and continuing calibration blanks
    - Method blank results
    - Instrument tuning
    - Internal standards results
    - Surrogate recovery results
    - Preparation logs
    - Any other raw data necessary to fully document the analyses performed on the subject sample group

QAPP Worksheet #14 -- Summary of Project Tasks (Continued)

Assessment/Audit Tasks

1. The laboratory selected to perform the analytical testing for this project will have current accreditation under the DoD Environmental Laboratory Accreditation Program (ELAP), which is based on the review of the laboratory's quality assurance manual, selected SOPs, SOP master list, list of major analytical instrumentation, performance test results, and an on-site assessment performed under DoD ELAP.

QAPP Worksheet #16 – Project Schedule/Timeline Table

Activities	Organization	Dates		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
TPP #4 – QAPP Amendment review	AECOM, USACE, JBLM, EPA, Ecology, DOH	11/27/18	11/27/18		
QAPP amendment based on TPP #4	AECOM	11/27/18	12/7/18	QAPP amendment	12/10/18
Fieldwork –Phase II well installation and sampling	AECOM	12/19/18	1/8/19		
Phase II Laboratory Analysis	ELLE	1/8/19	2/7/19		
Phase II Data Validation	AECOM	2/7/19	2/28/19		
Fieldwork – Additional well installation	Brice-AECOM JV	1/9/19	3/5/19		
Fieldwork – Additional well sampling	Brice-AECOM JV	3/6/19	3/12/19		
Additional well Laboratory Analysis	ELLE	3/13/1	4/23/19	Laboratory package	4/23/19
Additional well Data validation	Brice-AECOM JV	4/24/19	5/22/19	Validation package	5/22/19
TPP #5 – Field Investigation data review	AECOM, USACE, JBLM, EPA, Ecology, DOH	6/5/19	6/5/19		
Tentative Schedule Dates					
Draft Site Inspection (SI) report	AECOM	4/23/19	5/23/19	Draft SI report	5/23/19
Draft SI Report review	USACE, JBLM	5/23/19	6/22/19		
Draft SI report comment resolution	AECOM	6/22/19	7/6/19		
Draft Final SI report	AECOM	7/6/19	8/5/19	Draft Final SI Report	8/5/19
Draft Final SI report review	USACE, JBLM	8/5/19	9/4/19		
Final SI report	AECOM	9/4/19	10/4/19	Final report	10/4/19

Note: Phase II well installation and sampling to be performed under Task Order W912DW17F2085, additional well installation and sampling to be performed under Task Order W912DW18F2107

QAPP Worksheet #17 -- Sampling Design and Rationale

The intent of the investigation is to identify PFAS source areas on JBLM. Groundwater/surface water samples were collected from forty-four locations during the Phase I event. Results of Phase I were used to guide the selection of the Phase II monitoring well installation and sampling locations described in this QAPP Addendum. The areas with the highest concentration of the sum of six UCMR-3 compounds detected in Phase I samples will be prioritized in Phase II well installation and sampling. Sampling of fifteen existing wells and the installation and sampling of nineteen new wells will be conducted during Phase II.

This section describes the rationale and methodology for the specific sampling approach proposed for the Phase II sampling event. Additional information is available in the SOPs provided in Appendix A and the Data Management Plan provided in Appendix B.

PFAS Sampling Considerations

There are hundreds of commercially available products that may contain residual PFAS and many are found in the sampling environment. These can be divided into two basic categories: 1) the sampling equipment and 2) the items within the sampling environment not related to the sampling equipment. The sampling equipment includes items such as bailers, pumps, tubing, sample jars and lids, gloves, sharpies, decontamination liquids and equipment, metal scoops, aluminum foil, paper towels containing recycled material, coated field notebooks, etc. Items within the sampling environment not related to the sampling equipment include, but are not limited to, stain- and water-resistant fabrics found in outerwear and boots and in treated vehicle upholstery, personal care items, sunscreens and insect repellants, food wrappers/containers, residual fabric softeners on washed clothing, etc. As a precautionary measure, practical elimination of all of these items from the sampling environment is recommended.

Eliminating all items in the sampling environment that may be a potential source of PFAS contamination is particularly important as the various screening criteria and laboratory reporting limits for PFAS compounds are decreasing. For example, the EPA LHA for two commonly found PFAS compounds, PFOA and PFOS, separately or combined, is 70 ppt. The procedures prescribed in SOP A (Appendix A) shall be applied to each of the field activities described below.

Sampling Locations

The planned sampling locations were selected based on discussions with the project stakeholders during TPP #3, as described in Worksheet #9. A summary of the planned sampling locations and rationale is provided in Table 17-1. Figure 17-15 shows the planned Phase II sampling locations across the entire installation.

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Dig Permitting and Pre-Intrusive Work Preparation

JBLM-required permits for subsurface work will be obtained during the pre-intrusive work preparation period. AECOM will coordinate with the JBLM Technical Representative to procure and complete all JBLM-required permitting for well installation.

A pre-construction meeting will be held on-site prior to the initiation of intrusive field work planned for Phase II. This meeting will address health and safety, schedule, and field reporting during the field work. The driller will obtain "start cards" for drilling all borings and wells and will properly register each well with Ecology. Wells will be constructed by a licensed well driller in accordance with Ecology's Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 Washington Administrative Code).

Utility Location

All utilities will be located in accordance with SOP F (Appendix A) prior to any subsurface activities. AECOM will consult with JBLM and other appropriate representatives to identify potential utility locations at the site. AECOM will contact the One Call utility location center to have utilities marked. A private utility locator will be mobilized to locate any conductible buried utilities at each drilling location prior to surface penetration. The private utility locator will use toning, electromagnetic, or other equivalent equipment to conduct the utility locate. An AECOM representative will be present during the utility locate and will document the results. No surface penetration is allowed within 5 feet of a marked or otherwise identified utility.

Drilling and Monitoring Well Installation

All drilling and well installation activities proposed for Phase II will be conducted by a State of Washington-licensed well drilling contractor using sonic drilling methods. Sonic drilling methods, also known as vibratory drilling , uses an eccentrically oscillating drill head to produce high-frequency vibratory energy that is then transmitted down a drill string to a core barrel to quickly advance through the subsurface. Other than the soil or rock that is retrieved from inside the core barrel as a sample, drill cuttings are limited and are forced into the walls of the borehole. A drilling fluid such as water or air is usually not required with this drilling method. However, water may be used to cool the drill bit, if necessary, or to control heave.

Continuous soil cores will be collected during drilling and immediately logged upon retrieval. A tubular plastic sleeve with a sealed bottom will be placed beneath the core barrel. The core barrel will then be vibrated, causing the soil sample to be extruded into the plastic sleeve. Each plastic sleeve will be filled with no more than 3 feet of soil core. The plastic sleeve will then be marked with the sample interval using indelible ink. Cores will be approximately 6 inches in diameter, based on installation of 2-inch-diameter groundwater monitoring wells at some drilling locations (no 4-inch-diameter or larger wells are planned).

Sonic drilling utilizes a double-cased system using an inner core barrel and a larger override casing. This ensures that the borehole is continuously casing to the total depth, minimizing the potential for downhole cross contamination. To further prevent cross contamination across

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

separate water-bearing units, bentonite slurry seals will be injected into the subsurface when a significant aquitard (e.g., between the Upper Vashon and Lower Vashon Aquifers or between the Vashon Aquifer and Sea Level Aquifers) is encountered. When an aquitard is identified using the core sample collected with the smaller diameter inside core barrel, bentonite slurry will be injected into the outer casing, to a depth of several feet above the contact with the aquitard. After the bentonite has properly sealed, a smaller diameter casing will advanced through the bentonite seal into the next sampling interval. This smaller casing will now be the outer casing that seals the borehole annulus. Use of this methodology will be determined following discussions with the project technical team (JBLM, USACE and AECOM) based on conditions reported from the field

Recovered soil will be visually examined for evidence of contamination and classified in accordance with the Unified Soil Classification System (USCS). Soil will be field screened with a PID by inserting the PID probe into the plastic sleeve containing the soil core, assessing organic vapors along the length of the core, and documenting the results in the field logbook and boring logs. General headspace analysis procedures are described in SOP G (Appendix A). The PID will be calibrated in accordance with manufacturer's instructions at the beginning and end of each day. Soil samples will not be collected for analytical analysis.

Investigation derived waste (IDW) soil cuttings and core-barrel samples will be contained in labeled DOT-approved containers and managed as described below.

Groundwater monitoring wells will be installed in accordance with SOP H (Appendix A). The exact number of wells to be installed will be determined based on the interpretation of the data collected during Phase I and with the concurrence of the Technical Project Team. Well screen intervals will be determined based on the Phase I groundwater results and the observed field conditions during Phase II, in consultation with the USACE and JBLM.

Monitoring wells that are 50 feet or less in depth will be constructed of 2-inch diameter, flush-threaded Schedule 40 polyvinyl chloride (PVC) that will have a sand trap at the bottom with an estimated 10 feet of 0.010 slot well screen and blank well casing to ground surface and sealed with a lockable compression cap. The filter pack within the annular space around the screen will consist of 2/12 Monterrey sand and will be placed at least two feet above the top of the well screen. A well seal consisting of hydrated bentonite chips will be installed above the sand pack. Monitoring wells installed to depths greater than 50 feet will be constructed of 4-inch diameter, flush-threaded Schedule 40 PVC with a sand trap at the bottom, and an estimated 20 feet of 0.010 slot well screen with blank well casing to ground surface fitted with a lockable compression cap. The filter pack around the screen will consist of 2/12 Monterrey sand, and the well seal will consist of hydrated bentonite chips.

Wells will be completed with above-ground steel "stick-up" protective casings surrounded by three bollards in unpaved portions of the site, and with traffic-rated flush mount monuments in paved portions of the site.

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Boring logs and well construction diagrams will be completed that include the driller's license number and are signed by the licensed driller. The driller will upload these logs to Ecology's database, as required. The Washington State Well ID for each installed well will be provided by the well drilling contractor and the ID tags will be installed in each well monument.

Well Development

The t newly installed monitoring wells will be developed to establish a hydraulic connection between the well and the surrounding saturated formation, settle the filter pack, and remove accumulated sediment/suspended solids that may enter the well during installation. Standard methods for monitoring well development are described in SOP I (Appendix A). Water quality instruments will be calibrated in accordance with SOP C (Appendix A). Well development will be performed a minimum of 24 hours after well construction to allow time for the bentonite or grout seal to cure. Development will be performed by first using a surge block followed by a bailer (PVC or stainless steel) or pneumatic pump to remove sediments from the well and surrounding filter pack. Multiple iterations of surging and bailing will be required, dependent on the aquifer characteristics.

Once the bailed water is visually free of sediment, development will continue using high-flow pumping techniques (greater than 0.5 liter per minute) until the water quality parameters (temperature, pH, specific conductance, and turbidity) stabilize to within 10 percent of the previous reading for three consecutive measurements, or until five borehole volumes (well casing plus annular space) have been removed. Because the monitoring wells may be screened in silty material, water quality parameters, notably turbidity, may not stabilize using high-flow pumping techniques. If water quality parameters do not stabilize to within 10 percent after five well volumes, low-flow pumping techniques (less than 0.5 liter per minute) will be performed for an additional well volume to better document groundwater conditions encountered during low-flow groundwater sampling. Well development water will be contained in labeled DOT-approved containers and managed as described below.

The following information will be recorded during the development of each well:

- Date, time, personnel, and well designation
- Static groundwater levels
- Volume of water in well prior to development
- Volume of water removed
- Observations of water characteristics (e.g., color, odor, turbidity)
- Description of development technique

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Groundwater Sampling

Groundwater samples will be collected during the Phase II events using low-flow techniques in accordance with SOP B (Appendix A). Water quality instruments will be calibrated in accordance with SOP C (Appendix A). Field measurements, including pH, specific conductance, turbidity, dissolved oxygen (DO), temperature, salinity and oxidation reduction potential (ORP), will be recorded during sampling in accordance with SOP D (Appendix A). Groundwater samples collected at each location will be field screened using a shaker test. A small volume (~10-25 milliliters [mL]) of groundwater will be collected and shaken by the sample collector on-site. If foaming is noted within the sample, it will be documented in the field logbook and on the laboratory chain of custody (CoC) when samples are submitted for analysis. This will alert the laboratory to the possible presence of elevated concentrations of PFAS/AFFF. IDW will be contained in labeled DOT-approved containers and managed as described below.

Field Rinsate Blanks

A field rinsate blank will be collected and analyzed only if nondisposable equipment is used. Field rinsate blanks will consist of PFAS-free water that has passed over and/or through decontaminated sampling equipment. Surfaces and materials exposed during actual sampling will be rinsed to evaluate the effectiveness of sampling equipment decontamination procedures and the potential for equipment or field cross contamination. Rinsate blanks will be collected at a rate of one per day per medium when non-disposable equipment is used and analyzed for the 14 PFAS compounds. Field equipment that is rinsed during the collection of the blank will be documented in the field logbook.

Blind Field Duplicates

To the extent possible, locations for blind field duplicate samples will be chosen where the expectation is that contamination is greater than the reporting limit. The field duplicates will consist of groundwater and surface water samples at a rate of 1 per 10 samples per medium. Samples will be coded such that the laboratory cannot identify the well in which sample duplicates are collected from based on the information on the sample label. The samples will be analyzed for the same parameters as the primary sample. Field duplicates will be noted on the sample collection form or in the field logbook.

Trip Blanks

Trip blanks will accompany all samples as they are transported to and from the sampling site and then to the analytical laboratory. They will consist of a 250-mL HDPE bottle filled with PFAS free water. One trip will be included with each sample shipment. Trip blanks will be prepared by the laboratory at the time the sample containers are prepared for the site sampling.

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Sample Analyses

Worksheet #11 identifies six PFAS compounds that will be used to make decisions regarding potential source areas. However, Ecology and or DOH may issue cleanup standards that include a different combination of PFAS compounds. As a result, samples collected will be analyzed for all 14 EPA Method 537-Modified PFAS compounds.

Sample Identification

Sample containers will be labeled before the samples are collected. Care will be taken to ensure that the sample container labels correspond with the specified sample location identification numbers.

Monitoring Well Samples

Monitoring well samples collected during the Phase II sampling events will be named as follows:

- Monitoring Well Identification – Date (yymmdd). For example, monitoring well LT-4 sampled on February 30, 2019, would be labeled LT-4-190230.

Monitoring well duplicate samples collected during the Phase II sampling events will be labeled consecutively, as follows:

- GWDUP# - Date (yymmdd). For example, the first monitoring well duplicate sample collected on February 30, 2019, would be labeled GWDUP1-190230.

Field Rinsate Blanks

Field rinsate blank samples collected during the Phase I and Phase II sampling events will be labeled consecutively, as follows:

- FRB# - Date (yymmdd). For example, the first field rinsate blank collected on February 30, 2019, would be labeled FRB1-190230.

Trip Blanks

Trip blanks that will accompany collected samples through shipment to the analytical laboratory will be labeled as follows:

- TB – Date (yymmdd). For example, a trip blank accompanying a sample shipment on February 30, 2019, would be labeled TB – 190230.

IDW Handling and Management

Drill cuttings and purge/decontamination water will be placed in DOT-approved 55-gallon drums filled approximately two-thirds full. The drums will be transported to a storage location identified by JBLM. Stored IDW will be sampled for characterization. Characterization results will be provided to JBLM for use in determining final disposition. Final IDW disposition will be

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

JBLM's responsibility. Standard methods for IDW handling and management are described in SOP J (Appendix A).

Monitoring Well Surveying

All monitoring wells installed under this QAPP will be surveyed by a State of Washington-licensed surveyor. After the monitoring wells are installed, a notch or mark will be made at the top of the inner casing. The vertical location of these points will be surveyed to a reference point determined in the field and reported to within 0.01 foot. All elevations will be referenced to the North American Vertical Datum (NAVD) 1988. The horizontal locations of each point will be documented in North American Datum (1983/91) Washington State Plane North Zone with an accuracy of up to 0.1 foot. The top-of-casing and ground surface elevations and casing locations will be surveyed. Standard methods for surveying are described in SOP K (Appendix A)

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Table 17-1 Planned Sampling Location Rationale

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Figure Reference
93-MFS-C5-3	Groundwater	20-30	Assess for the presence of PFAS in shallow groundwater within Landfill #5	Landfill #5	Sequalitchew Springs	17-25
MW-2008-1	Groundwater	17-27	Assess for the presence of PFAS in shallow groundwater within Landfill #5	Landfill #5	Sequalitchew Springs	17-25
LF4-MW-03A	Groundwater	26-41	Assess for the presence of PFAS in shallow groundwater adjacent to Landfill #4, in the vicinity of Sequalitchew Springs and Well 12B.	Landfill #4	Sequalitchew Springs	17-26
LF4-MW-01A	Groundwater	37-52	Assess for the presence of PFAS in shallow groundwater adjacent to Landfill #4, in the vicinity of Sequalitchew Springs and Well 12B.	Landfill #4	Sequalitchew Springs	17-26
LF4-MW-01B	Groundwater	119-124	Assess for the presence of PFAS in shallow groundwater adjacent to Landfill #4, in the vicinity of Sequalitchew Springs and Well 12B.	Landfill #4	Sequalitchew Springs	17-26
LC- 92D-1	Groundwater	192-212	Assess for the presence of PFAS in deep groundwater adjacent to Landfill #4 and downgradient of Gray Field	Landfill#4 and Gray Field	Bell Hill #3	17-26
LC- 92D-2	Groundwater	238-258	Assess for the presence of PFAS in deep groundwater adjacent to Landfill #4 and downgradient of Gray Field	Landfill#4 and Gray Field	Bell Hill #3	17-26
LC- 93D-1	Groundwater	195-215	Assess for the presence of PFAS in deep groundwater adjacent to Landfill #4 and downgradient of Gray Field	Landfill#4 and Gray Field	Bell Hill #3	17-26

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Table 17-1 Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Figure Reference
LC- 93D-2	Groundwater	232-252	Assess for the presence of PFAS in deep groundwater adjacent to Landfill #4 and downgradient of Gray Field	Landfill#4 and Gray Field	Bell Hill #3	17-26
JP-MW-03	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater downgradient of Gray Field	Gray Field Hangars	Well 17	17-21
03075-MW02	Groundwater	20-35	Assess for the presence of PFAS in shallow groundwater downgradient of Gray Field	Gray Field Hangars	Well 17	17-21
CW-32A	Groundwater	100-110	Assess for the presence of PFAS in shallow groundwater	Clover Creek and McChord Hangars	North Well	17-16
CW-32B	Groundwater	242-247	Assess for the presence of PFAS in deep groundwater	North McChord Hangars and Runways	North Well	17-16
CW-32C	Groundwater	362-372	Assess for the presence of PFAS in deep groundwater	McChord Hangars, Runways and Clover Creek	North Well	17-16
97-MW-1	Groundwater	14-29	Assess for the presence of PFAS in shallow groundwater	Gray Field Hangars	Well 14 and Well 20	17-19
2018-FT033-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater adjacent to FT033, McChord Field	FT033, McChord Hangars and Runways	North Well	17-17
2018-03106-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater adjacent to Gray Field ANG hangar	Gray Field Hangars and Runways	Well 14 and Well 20	17-19
2018-FTLE17-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater within former fire training area FTLE-17	Gray Field Hangars and Runways, and FTLE-17	Well 14	17-19
2018-03273-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater adjacent to Gray Field Hangar 03273	Gray Field Hangars and Runways	Well 14	17-20

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Table 17-1 Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Figure Reference
2018-SWMU47-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater downgradient of SWMU 47 FTA and Washrack 6 and upgradient of Well 14	SWMU 47 and Washrack 6	Well 14	17-20
2018-05275-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater downgradient of Gray Field and upgradient of Well 17	Gray Field Hangars and Runways	Well 17	17-22
2018-2014-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater near Firehouse and upgradient of Well 17	Firehouse (Building 2014)	Well 17	17-22
2018-4074-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater adjacent to historical water proofing facility	Historical Water Proofing and Laundry Facilities	Well 17	17-23
2018-1401-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater adjacent to historical laundry facility	Historical Water Proofing and Laundry Facilities	Well 17	17-23
2018-LF9-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater near Landfill #9	Landfill #9	Well 22	17-23
2018-LT-12	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater at the north end of McChord Field	North McChord Hangars and Runways	North Well	17-16
2018-FT027-MW1	Groundwater	40-50	Assess for the presence of PFAS in shallow groundwater within former fire training area FT027	FT027 and McChord Runways	North Well	17-16
2019-LT-13	Groundwater	180-200	Assess for the presence of PFAS in deep groundwater	North McChord Hangars and Runways	Scotts Well	17-16
2019-LT-14	Groundwater	180-200	Assess for the presence of PFAS in deep groundwater	North McChord Hangars and Runways	Scotts Well	17-16
2019-LT-15	Groundwater	180-200	Assess for the presence of PFAS in deep groundwater	North McChord Hangars and Runways	North Well	17-16

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Table 17-1 Planned Sampling Locations Rationale (continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Rationale	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Figure Reference
2019-LT-16	Groundwater	90-110	Assess for the presence of PFAS in deep groundwater	FT033, McChord Hangars and Runways	Ponders Well	17-18
2019-LT-17	Groundwater	280-300	Assess for the presence of PFAS in deep groundwater downgradient of historical laundry facility, waterproofing, and Landfill #9	Historical Water Proofing, Laundry Facilities, and Landfill #9	Well 22 and Hoffman Hill #2	17-24
2019-LT-18	Groundwater	280-300	Assess for the presence of PFAS in deep groundwater adjacent to historical laundry facility	Historical Water Proofing and Laundry Facilities	Well 17	17-22
2019-LT-19	Groundwater	180-200	Assess for the presence of PFAS in deep groundwater	North McChord Hangars and Runways	Scotts Well	17-16

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

Table 17-1 Planned Sampling Locations Rationale (continued)

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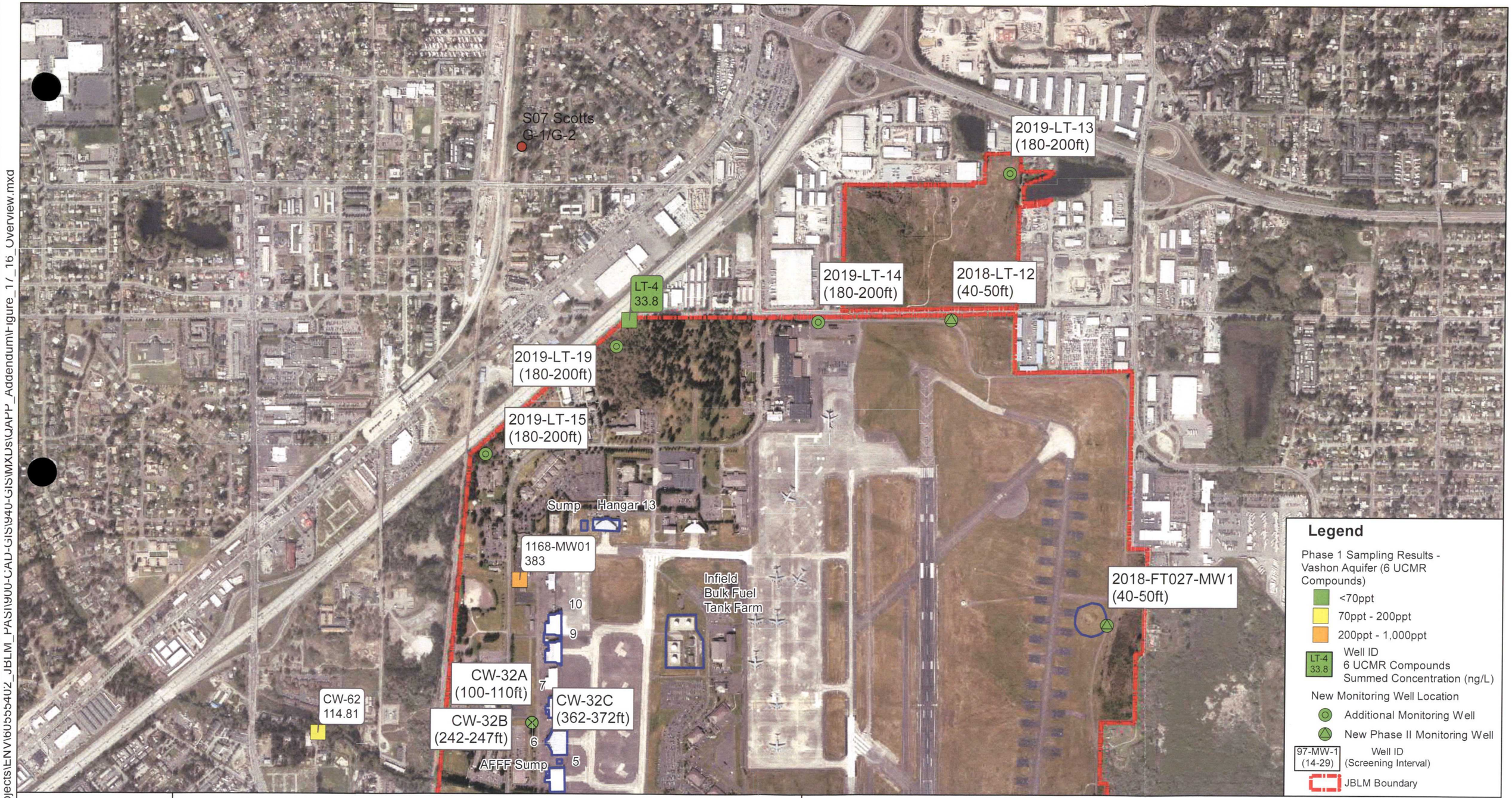
Figure 17-15 Proposed Phase II Sampling Locations, Joint Base Lewis McChord

Region 10
1200 Sixth Ave.
Seattle, WA 98101



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PUBLIC WORKS
JOINT BASE LEWIS-McCHORD

N

0 0.225 0.45 0.9 Miles

Figure 17-16

Phase II Sampling Locations

North McChord Runway and Hangar Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-17

Phase II Sampling Locations

FTA-033/McChord Hangars Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-18

Phase II Sampling Locations

McChord Hangars Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-19

Phase II Sampling Locations

North Gray Field Hangars/FTLE-17 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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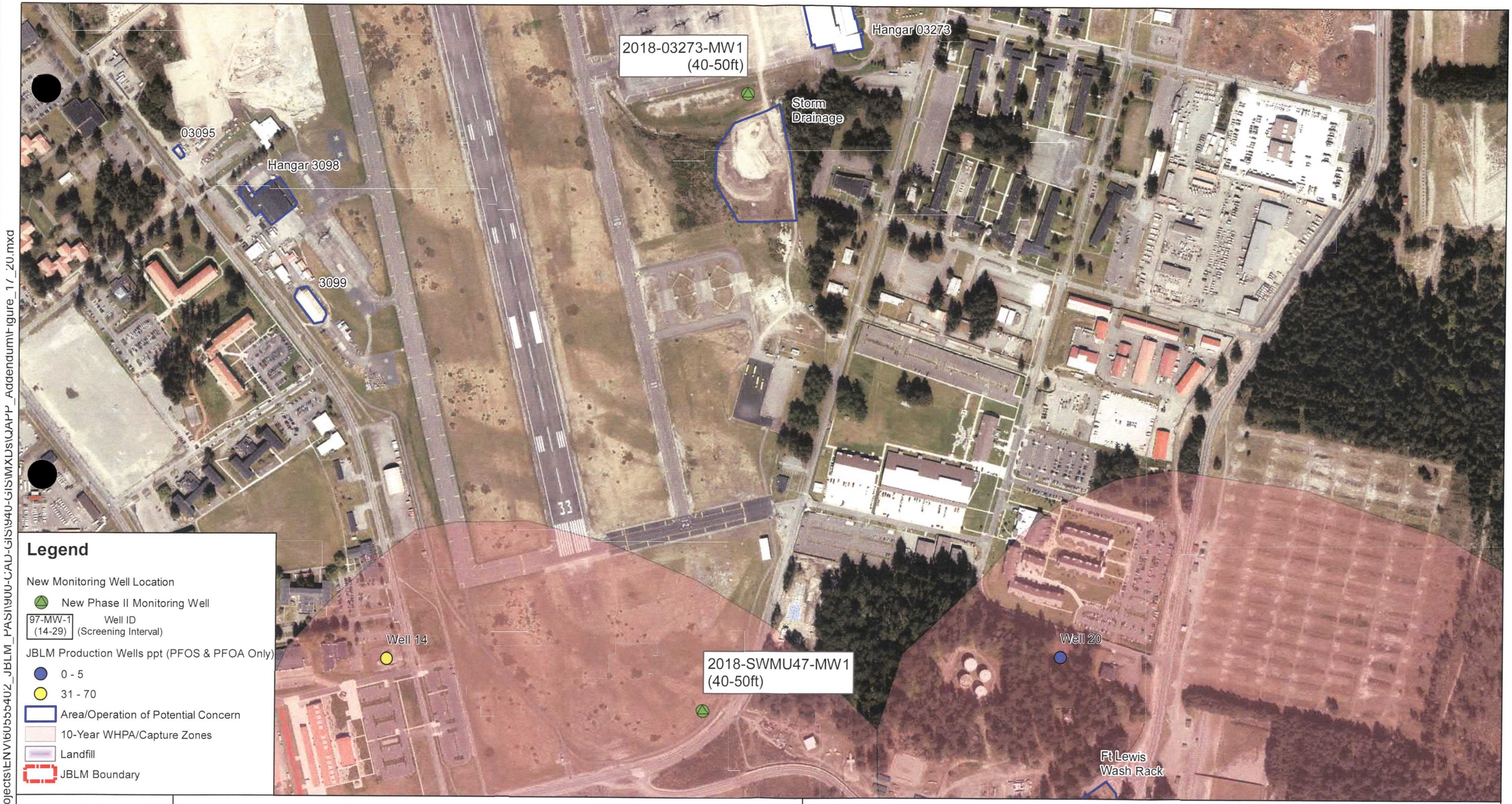

Figure 17-20

Phase II Sampling Locations

South Gray Field Hangars/SWMU-47 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

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QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-21

Phase II Sampling Locations

Gray Field Hangars Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-22

Phase II Sampling Locations

Gray Field Hangars and Fire Station Building-2014 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-23

Phase II Sampling Locations

Historical Water-proofing/Laundry/Landfill 9 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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HOFFMAN HILL NO. 1

2019-LT-17 (280-300ft)

Well 22

Legend

- Additional Monitoring Well
- 97-MW-1 (14-29) — Well ID (Screening Interval)
- JBLM Production Wells ppt (PFOS & PFOA Only)
- 71 - 140
- Off Site Wells
- 10-Year WHPA/Capture Zones
- JBLM Boundary

N

0 0.075 0.15 0.3 Miles

Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

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Figure 17-24

Phase II Sampling Locations

Historical Water-proofing/Laundry/Landfill 9 Source Areas
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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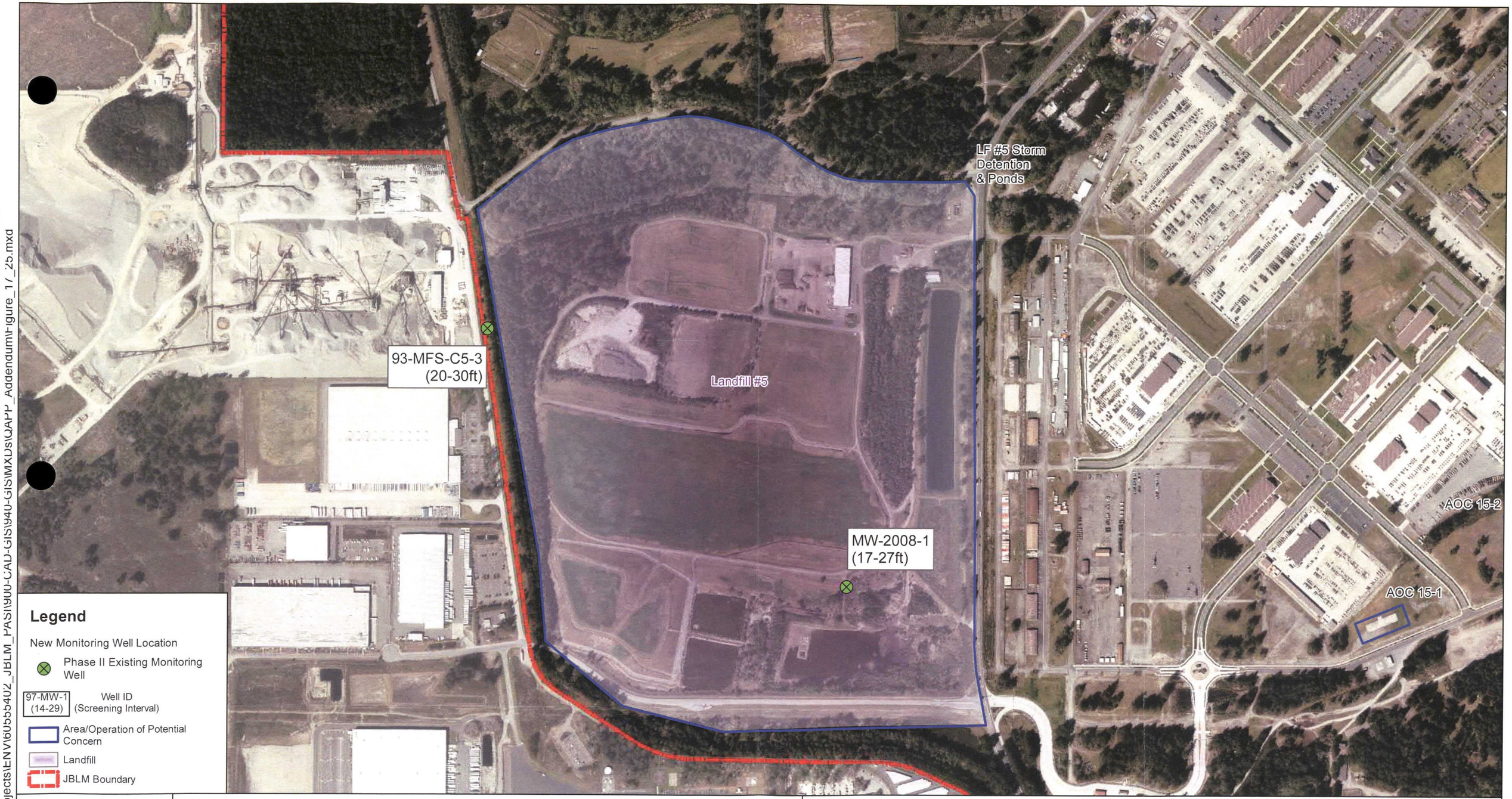

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Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-25

Phase II Sampling Locations

Landfill #5 Source Area
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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PUBLIC WORKS
JOINT BASE LEWIS-MCCHORD WASHINGTON

N

0 0.125 0.25 0.5 Miles

Aerial Sources: JBLM Public Works 2016, UTM10, NAD83, NAVD88.sid

Figure 17-26

Phase II Sampling Locations

Landfill #4 Source Area
PFAS Site Inspection
Joint Base Lewis McChord
Lakewood, WA

QAPP Worksheet #17 -- Sampling Design and Rationale (Continued)

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QAPP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Sampling SOP Reference[a]	Figure Reference
93-MFS-C5-3	Groundwater	20-30	14 PFAS Compounds	1	Landfill #5	Sequalitchew Springs	A,B and Worksheet #17	17-25
MW-2008-1	Groundwater	17-27	14 PFAS Compounds	1	Landfill #5	Sequalitchew Springs	A,B and Worksheet #17	17-25
LF4-MW-03A	Groundwater	26-41	14 PFAS Compounds	1	Landfill #4	Sequalitchew Springs	A,B and Worksheet #17	17-26
LF4-MW-01A	Groundwater	37-52	14 PFAS Compounds	1	Landfill #4	Sequalitchew Springs	A,B and Worksheet #17	17-26
LF4-MW-01B	Groundwater	119-124	14 PFAS Compounds	1	Landfill #4	Sequalitchew Springs	A,B and Worksheet #17	17-26
LC- 92D-1	Groundwater	192-212	14 PFAS Compounds	1	Landfill#4 and Gray Field	Bell Hill #3	A,B and Worksheet #17	17-26
LC- 92D-2	Groundwater	238-258	14 PFAS Compounds	1	Landfill#4 and Gray Field	Bell Hill #3	A,B and Worksheet #17	17-26
LC- 93D-1	Groundwater	195-215	14 PFAS Compounds	1	Landfill#4 and Gray Field	Bell Hill #3	A,B and Worksheet #17	17-26
LC- 93D-2	Groundwater	232-252	14 PFAS Compounds	1	Landfill#4 and Gray Field	Bell Hill #3	A,B and Worksheet #17	17-26
JP-MW-03	Groundwater	40-50	14 PFAS Compounds	1	Gray Field Hangars	Well 17	A,B and Worksheet #17	17-21
03075-MW02	Groundwater	20-35	14 PFAS Compounds	1	Gray Field Hangars	Well 17	A,B and Worksheet #17	17-21
CW-32A	Groundwater	100-110	14 PFAS Compounds	1	Clover Creek and McChord Hangars	North Well	A,B and Worksheet #17	17-16
CW-32B	Groundwater	242-247	14 PFAS Compounds	1	North McChord Hangars and Runways	North Well	A,B and Worksheet #17	17-16
CW-32C	Groundwater	362-372	14 PFAS Compounds	1	McChord Hangars, Runways and Clover Creek	North Well	A,B and Worksheet #17	17-16
97-MW-1	Groundwater	14-29	14 PFAS Compounds	1	Gray Field Hangars	Well 14 and Well 20	A,E and Worksheet #17	17-19
2018-FT033-MW1	Groundwater	40-50	14 PFAS Compounds	1	FT033, McChord Hangars and Runways	North Well	A,B and Worksheet #17	17-17

QAPP Worksheet #18– Sampling Locations and Methods/SOP Requirements Table (Continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Sampling SOP Reference[a]	Figure Reference
2018-03106-MW1	Groundwater	40-50	14 PFAS Compounds	1	Gray Field Hangars and Runways	Well 14 and Well 20	A,B and Worksheet #17	17-19
2018-FTLE-17-MW1	Groundwater	40-50	14 PFAS Compounds	1	FTLE-17 and Gray Field Hangars and Runways	Well 14 and Well 20	A,B and Worksheet #17	17-19
2018-03273-MW1	Groundwater	40-50	14 PFAS Compounds	1	Gray Field Hangars and Runways	Well 14 and Well 20	A,B and Worksheet #17	17-20
2018-SWMU47-MW1	Groundwater	40-50	14 PFAS Compounds	1	SWMU 47 and Washrack 6	Well 14	A,B and Worksheet #17	17-20
2018-05275-MW1	Groundwater	40-50	14 PFAS Compounds	1	Gray Field Hangars and Runways	Well 17	A,B and Worksheet #17	17-22
2018-2014-MW1	Groundwater	40-50	14 PFAS Compounds	1	Firehouse (Building 2014)	Well 17	A,B and Worksheet #17	17-22
2018-4074-MW1	Groundwater	40-50	14 PFAS Compounds	1	Historical Waterproofing and Laundry Facility	Well 17	A,B and Worksheet #17	17-23
2018-1401-MW1	Groundwater	40-50	14 PFAS Compounds	1	Historical Waterproofing and Laundry Facility	Well 17		17-23
2018-LF9-MW1	Groundwater	40-50	14 PFAS Compounds	1	Landfill #9	Well 22	A,B and Worksheet #17	17-23
2018-LT-12	Groundwater	40-50	14 PFAS Compounds	1	McChord Hangars and Runways	North Well	A,B and Worksheet #17	17-16
2018-FT027-MW1	Groundwater	40-50	14 PFAS Compounds	1	FT027 and McChord Runways	North Well	A,B and Worksheet #17	17-16
2019-LT-13	Groundwater	180-200	14 PFAS Compounds	2	McChord Hangars and Runways	Scotts Well	A,B and Worksheet #17	17-16
2019-LT-14	Groundwater	180-200	14 PFAS Compounds	2	McChord Hangars and Runways	Scotts Well	A,B and Worksheet #17	17-16
2019-LT-15	Groundwater	180-200	14 PFAS Compounds	2	McChord Hangars and Runways	North Well	A,B and Worksheet #17	17-16
2019-LT-16	Groundwater	90-110	14 PFAS Compounds	2	FT033, McChord Hangars and Runways	Ponders Well	A,B and Worksheet #17	17-18
2019-LT-17	Groundwater	280-300	14 PFAS Compounds	2	Historical Waterproofing, Laundry Facility, and Landfill #9	Well 22 and Hoffman Hill #2 Well	A,B and Worksheet #17	17-24

QAPP Worksheet #18– Sampling Locations and Methods/SOP Requirements Table (Continued)

Sampling Location/ ID Number	Matrix	Screen Interval (ft bgs)	Analytical Group	Total Number of Samples	Nearest Potential Area of Concern	Nearest Drinking Water Production Well	Sampling SOP Reference[a]	Figure Reference
2019-LT-18	Groundwater	280-300	14 PFAS Compounds	2	Historical Waterproofing and Laundry Facility	Well 17	A,B and Worksheet #17	17-22
2019-LT-19	Groundwater	180-200	14 PFAS Compounds	2	McChord Hangars and Runways	Scotts Well	A,B and Worksheet #17	17-16

[a]SOP or worksheet that describes the sample collection procedures (see Appendix A).

QAPP Worksheet #20 – Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Environmental Samples	No. of Field Duplicates	No. of MS/MSDs	Equipment Rinsate Samples	Total No. of Samples to Lab
Groundwater	14 PFAS Compounds	34	4	2	14	54

17 December 2018

ADDENDUM 1
Project-Specific Quality Assurance Project Plan
PFAS Preliminary Assessment/Site Inspection

Joint Base Lewis-McChord

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